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A Summary of Current Program 10/1/64
and Preliminary Report of Progress
for 10/1/63 to 9/30/64

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TRANSPORTATION AND FACILITIES

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AGRICULTURAL RESEARCH SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE

This progress report is primarily a tool for use of Department scientists and administrators in program coordination, development, and evaluation; and for use of advisory committees in program review and development of recommendations for future research programs.

The summaries of research progress include some tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to members of Department staff, advisory committee members, and others having a special interest in the development of public agricultural research programs.

This report also includes a list of publications reporting research results, issued between October 1, 1963 and September 30, 1964. Current agricultural research findings are also published in the monthly USDA publications, Agricultural Research and Agricultural Marketing. This progress report was compiled in the Transportation and Facilities Research Division, Agricultural Research Service, U. S. Department of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
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INTRODUCTION

Transportation and marketing facilities research of ARS as used in this report is concerned with the structures, equipment, containers, devices, work methods, and operating methods used in marketing and transporting farm and food products from the farms to consumers. It seeks to find ways to improve these physical elements and handling methods in order to increase their efficiency and effectiveness in performing the numerous operations involved, increase labor productivity, and help hold down marketing costs. The research deals largely with the application of engineering--economic and marketing principles.

The functions to which these physical elements, handling methods, and labor relate include essentially all marketing operations, especially those directly applicable to the commodities in the physical sense, such as assembling, preparing for market, processing, packaging, precooling, loading, transporting, unloading, storing, warehousing, and wholesale and retail distribution. The research concerns all agricultural and food commodities at all places in the marketing channel from the local farm market through the retail store.

The investment in agricultural marketing facilities and equipment is tremendous and increasing rapidly. Exclusive of transportation, at least \$1 billion is expended annually on new and improved plants, warehouses, and stores for assembling, processing, storing, and distributing farm and food commodities. The component costs of marketing have been rising rapidly. Hourly earnings for persons employed in marketing farm products have risen 92 percent from the base years 1947-49 to 1963. However unit labor costs have risen only 33 percent during the same period. If the full increase in the cost of labor during the past 15 years had been reflected in higher marketing costs, the total marketing labor bill in 1963 would have been increased an additional \$9 billion. In the marketing of food commodities in 1963, at least \$30 billion (75 percent of the total food marketing bill) were expended on marketing operations that are directly affected by research in the areas covered by this report.

Most of the research by industry differs substantially from that done by public agencies. It relates primarily to the development of products or services which the individual firms offer for sale. Some of the research and developmental work of industry involves adaptation of research findings of public agencies. Since most industry firms are doing business for profit their research is profit motivated. Most of the research findings are trade secrets and therefore not made public. Thus, research contributions to public knowledge in this field must come mainly from public-supported research. Such research has special significance to the small firms that cannot afford to do their own research.

Industry contributes to USDA research in numerous ways, particularly in permitting the free use of its facilities, equipment, materials, and supplies

in numerous research experiments and tests. Also in some cases industry groups have made cash contributions to help finance USDA research in this field. Research by USDA frequently serves as a catalyst or stimulus to industry research. Indicative of the research results being obtained and the extent of their application by industry are the following examples:

Philadelphia Food-Distribution Center Nearing Completion. In Philadelphia, as a result of studies of the facilities used for handling food, construction is almost complete on the 388-acre food-distribution center. When completed, the development will represent an investment of over \$100 million and provide employment for about 12,000 people in handling and processing all types of food and food products and related service industries. Prior to the development of the center, the tax income from the site was \$29,000 per year and when construction is completed, will be almost \$2.0 million annually. The old market has been replaced with three apartment buildings and a number of townhouses, increasing the assessed valuation from about \$7.0 to \$27.0 million.

"Hot" Processing of Hog Carcasses. Experimental results on processing "hot" hog carcasses directly from the killing floor indicate that this technique is feasible. Conventional processing of chilled carcasses requires approximately 118 hours from the killing floor to the finished product; the "hot" processing method requires only 15 hours. Hot processing eliminates the need for a large and expensive chill cooler, reduces the holding cooler space requirements, and eliminates excess handling of carcasses and cuts in slaughtering and processing plants. Tests show that the new procedure causes no deterioration in quality factors such as taste, tenderness and juiciness and the carcass yield is not affected. With approximately 80 million hogs slaughtered and processed in commercial facilities annually, the adoption of this procedure could save the industry several million dollars each year in reduced labor and facility costs.

Development of Design for Multi-Purpose Van Container. A design for a multi-purpose van container for transporting farm and food products has been developed. When completed, the van can haul frozen and nonfrozen products as well as dry cargo. It can be moved by highway, rail, water, and possibly air. When widely adopted, and industry interest indicates it will be, the van container will bring significant reduction in the annual bill for transporting agricultural products and supplies, and at the same time furnish better protection to products which require special environment during transit.

Institutional Wholesalers' Margin Reduction. The institutional wholesalers' traditionally high margins of 18 to 20 percent are being lowered to 12 to 15 percent. The Division's research to develop improved practices for the industry is a major cause for the margin reduction.

New Facilities for Handling Meat and Poultry in New York City. As a result of studies by this Division, an additional \$40.0 million complex of facilities is being planned for handling meat and poultry, for which the New York City Board of Estimate has allotted \$6.1 million for site acquisition and design. The facilities are being planned adjacent to the new \$36.0 million fruit and vegetable facility that is under construction at Hunts Point and

will replace the 14th Street and Brook Avenue Markets. Total annual saving in handling fruits, vegetables, meat, and poultry in new facilities is estimated to be almost \$25 million.

Experimental In-Line Egg Cleaner Minimizes Spoilage Hazards and Breakage.

An experimental in-line egg cleaner, developed under a research contract with the University of California, has recently been field-tested successfully in a commercial plant by ARS personnel. The tests in a commercial plant indicate that cleaning effectiveness is more than 70 percent better than commercial cleaners now in use while the breakage rate and spoilage hazard is greatly reduced. Based on the assumption that approximately 20 percent of the 5 billion dozen eggs sold annually off U. S. farms undergo some type of cleaning treatment, industry-wide use of the new cleaner could result in millions of dollars saved annually.

A New Corn Drying Process. The development of a new corn drying process--called dryeration--promised not only to reduce the drying damage to shelled corn, but also to increase materially the drying capacity of conventional commercial dryers. The dryeration process, combining aeration and heated air drying, permits use of high drying-air temperatures; eliminates cooling in the dryer; and produces corn with minimum damage.

Uniform Accounting for Grocery Wholesalers. The Division developed a uniform set of accounts for the food wholesale industry. Three national trade associations are now operating figure exchanges, using the uniform set of accounts, and are improving the member firms' efficiency through this activity.

Prepackaging Western Lettuce at Shipping Point. When lettuce is prepackaged at shipping point about one-third of the weight of the lettuce is eliminated by the removal of the wrapper leaves and about 30 cents per box is saved on transcontinental shipments. Prepackaged lettuce shipped to eastern markets arrived in a condition comparable to the conventionally packed lettuce. It is estimated that if only one-half of the rail shipments were shipped prepackaged, the freight saving would exceed 6 million dollars per year.

The professional staff of the Division is much too small to give adequate attention to the problems now being studied and to undertake other new and urgent research represented by pending proposals. Technology is changing rapidly in the physical elements and methods applicable to marketing operations. It is important that the application of new technology be explored before, instead of after, major investments are made in new plants and equipment, if costly mistakes are to be avoided.

RESEARCH PROGRAM OF STATE AGRICULTURAL EXPERIMENT STATIONS

Research concerned with the economics of marketing at the State Agricultural Experiment Stations is reported under the appropriate areas of work of the Multiple Use Report, Marketing Economics Division. Likewise, research dealing with facilities and transportation conducted by the agricultural engineers at the State Experiment Stations is reported in the Multiple Use Report of the Agricultural Engineering Division, Areas 4, 5, and 9. Related research in food science and technology is reported in the Multiple Use Report of the Utilization Research and Development Divisions.

AREA NO. 1. PLANNING MARKETING FACILITIES

Problem. The efficient marketing of agricultural products requires a continual movement of products through a succession of facilities of various kinds in order to prepare, store, and distribute properly a continuing supply of food and related products desired by consumers in the best possible condition at the least possible cost. In many cases the products pass through facilities that are inefficient, inadequate, antiquated, poorly designed, equipped, and located. This results in much of the inefficiency and high cost of handling operations, causes excessive spoilage and product deterioration, and obstructs the orderly flow of agricultural products from producers to consumers. These inefficiencies are reflected in lower prices to producers, higher prices to the consumer, and a greater spread between the prices producers receive and prices paid by consumers. New technology in producing as well as consuming units, changes in population, changes in the size, number, and location of marketing firms, increased labor costs, the need for greater mechanization, and the effects of urban renewal, redevelopment, and other public programs require the construction of new or improved marketing facilities. The complexity of the various types of facilities; the need to incorporate the highest degree of efficiency possible into the marketing facilities; the fact that most people who design and build facilities are without experience in such an undertaking; and the widespread effect of such facilities on producers, handlers, and consumers are reasons why public guidance and assistance in planning, improving, and promoting the construction of modernized marketing facilities are necessary.

Work in this area by State Experiment Stations, State Departments of Agriculture, and State Extension Services is usually on a cooperative and informal basis with personnel of the Marketing Facilities Planning Staff. The work done by industry and private groups is by engineering and architectural firms retained to develop plans and specifications for specific facilities or by firms developing, promoting, and merchandising equipment or services. Much of the work by private groups is based upon the results of USDA studies and often, as their work progresses, many rely heavily upon and confer frequently with Department representatives.

USDA PROGRAM

Terminal Wholesale Market Planning. The Marketing Facilities Planning Staff, Hyattsville, Maryland, upon request from and with assurance of cooperation of all groups and individuals interested in improving marketing facilities, conducts comprehensive studies of wholesale marketing facilities in specific urban areas. Studies are conducted (1) upon specific request of groups of wholesalers, municipal and/or State authorities, (2) when there is a clear need for improved facilities, (3) when local agencies are willing to cooperate and assist in doing the required work, (4) when there is adequate reason to expect that recommended improvements in the facilities will be

completed, and (5) where facilities constructed can be used as demonstrations for others who are planning facility improvements in other cities.

Assistance in planning improved facilities through which farm products must move from the producer to the consumer is limited to the technical assistance and guidance of specialists in various commodity areas. The demand for this type of assistance has increased because of urban renewal, redevelopment, and other public programs in many cities are dislocating wholesale food markets. Studies were made or are underway in Boston, Massachusetts, Chicago, Illinois, Springfield, Massachusetts, Milwaukee, Wisconsin, Baton Rouge, Louisiana, Pittsburgh, Pennsylvania, and San Juan, Puerto Rico.

Preliminary and Followup Work in Terminal Market Areas. This area of work provides technical assistance in preliminary, consulting, and followup work in terminal market areas that are planning, constructing, or otherwise improving existing facilities. In addition to this, work is underway to delineate the problems that are being encountered in those markets that have moved into improved facilities in order to improve the efficiency of markets that are currently in the planning stages. During the year specific requests were made and assistance was rendered in planning improvements in wholesale food markets in 10 locations. Preliminary work was completed in four locations.

Production Area and Independent Marketing Facilities. This area of the program is conducted by the Marketing Facilities Planning Staff upon request from and with the cooperation of State and local authorities, especially State Departments of Agriculture, trade groups, State Extension Services, and industrial marketing and research firms. Assistance is provided for planning various kinds of marketing facilities in production areas and includes work on the design, layout, location, equipment, work methods, costs, and benefits. Facilities include poultry processing and egg assembly plants, livestock auctions, stockyards, slaughter plants, shipping point facilities for assembling, grading, and packing fruits and vegetables in producing areas as well as the facilities required for handling other agricultural products between the farmer and the consumer. This is a continuing program embracing studies and analysis of facility needs at particular locations and makes specific recommendations for new or improved facilities and for improved handling methods and techniques to increase the efficiency of the marketing operations involved.

The program utilized 19.8 professional man-years of which 13.5 were devoted to terminal wholesale market planning, 1.5 to preliminary and followup work, and 4.8 to planning production area and independent marketing facilities.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Terminal wholesale market planning.

During the year assistance was provided seven major cities in developing plans for improved handling of food at the wholesale level. Public assistance programs, such as urban renewal and highway development, have complicated the problems of old, poorly designed and located facilities in the cities where work is underway. These programs have served to magnify the problems and provide a stimulus to motivate the cities, wholesalers, and others in improving the facilities where food is being handled. Most problems have resulted in higher cost of operation, greater inefficiencies, unnecessary waste and spoilage, and added congestion in an already intolerable situation. Studies in Milwaukee, Pittsburgh, and Baton Rouge have been completed. The study of the wholesale markets in Chicago is progressing and has passed the midway point. Studies of the facilities in Boston, Springfield, and San Juan are completed and final reports are in draft form.

1. Chicago, Illinois. One of the most complicated and involved studies ever undertaken by this Staff is progressing and is estimated to have passed the halfway point. Field work is almost completed and preliminary analysis is underway. The final report required under the contract portions of this study is nearing completion.

The 750 wholesale operators handling meat, fruits and vegetables, poultry, butter, eggs, cheese, frozen food, and groceries handled over 7.1 million tons of products with a wholesale value of \$2.87 billion annually. Selected costs of moving these products through the wholesale facilities in the city amount to over \$132 million annually. Improvements and recommendations have not been formulated at this time, but it is reasonable to expect that savings as great as, or greater than, most cities where studies have been completed can be realized in Chicago.

2. Boston, Massachusetts. Studies in Boston are completed and the final report is in the process of preparation. During the year the findings were presented in public meetings which were attended by wholesalers, transport officials, industry officials, city, and State authorities. Several individual commodity groups were presented the findings as they pertained to their specific group. Some groups have requested additional conferences with the research personnel assigned this project.

During the year an individual study of the benefits that might be derived from the relocation of only the operators in the Faneuil Hall area was completed at the request of Boston city officials. The savings and benefits from only a partial relocation are substantial, but do not approach the \$5.0 million estimated savings in distributing food in the area by complete relocation and improvement.

Numerous conferences were held with officials in New Bedford and with the Boston Florists Association to implement the findings of the studies previously conducted in connection with the Boston study.

In the early 1950's part of the wholesale operators handling meat relocated and experienced rather dramatic success. In the following 10-year period the volume handled by these operators more than doubled and the value of their leases increased about \$25,000 each. The operators who did not relocate have been struggling continuously to remain competitive.

Every effort possible is being extended to obtain a complete alleviation of the problems that are being encountered by all wholesale operators in the city.

3. Springfield, Massachusetts. Data collected in Springfield indicates that 111 firms received about 625 thousand tons of 4 food commodities annually. Analysis indicates that old, obsolete, and inadequate Columbus-Lyman market and other food wholesaling facilities elsewhere in the city should be replaced by modern facilities. Floor space used by the 105 independent dealers amounted to 1,099,412 square feet. It is estimated that 59 independent wholesale dealers presently occupying 349,868 square feet would relocate on a new market site and need only 155,104 square feet of space in 5 buildings. The rental value would increase from \$340,424 to \$459,000 due to present construction costs for modern facilities that lend themselves to more profitable operations. Increased rents would be more than offset by other savings. The total net savings on cartage, handling, transfers, spoilage, deterioration, breakage, and shrinkage are estimated at about \$950,000 annually. Six other dealers would probably occupy space as tenants in a refrigerated warehouse and two others plan to build separate facilities according to their own specifications on the site. Five possible sites have been suggested as suitable for development of a food-distribution center. Civic, public, financial, and food marketing groups are currently assembling land parcels.

A presentation of findings was given to more than 100 interested persons. The information was presented in order that public, civic, financial, and trade groups might prepare to take action toward relocation of some wholesale food firms in the path of the new interstate Route 91 and other urban redevelopment programs.

Special meetings have been held with the various trade groups to discuss their role in obtaining improved wholesale food handling facilities as well as with real estate developers and financiers.

The final report has been prepared and is in the process of being edited prior to publication.

4. Milwaukee, Wisconsin. Findings of the study of wholesale fresh fruit and vegetable market facilities in Milwaukee indicated that after an allowance for increased rents, an estimated annual net savings of \$56,000 would be possible.

The 23 independent wholesale operators in Milwaukee whose present facilities will be rendered unsuitable for operation as a result of highway improvement would require 2 buildings. The new facilities would contain about 152,000 square feet of space, including restaurant facilities. This is about 80 percent of the present space occupied. Railroad tracks at the rear of the buildings would accommodate 52 cars and parking space for about 195 vehicles is included in the plans presented.

The fresh fruit and vegetable facilities and expansion space would require about 20 acres of land and could be relocated on any one of 4 sites evaluated in the report that was published. The total cost of land for the required acreage would be about \$130,000 and the cost of buildings slightly over \$1.5 million for a total investment of about \$1.7 million.

5. Pittsburgh, Pennsylvania. During the year this project was terminated, the report published, and the work required of a followup nature transferred to the projects covering preliminary and followup work of terminal market studies.

6. San Juan, Puerto Rico. During the year a presentation of the findings of the studies in Puerto Rico was made to all interested groups. A model of the facilities proposed was constructed and is on display in the Department of Agriculture in San Juan. The report containing the findings has been reviewed by all cooperators and is in the final stages of preparation for publication.

The report contains recommendations for the relocation of the 83 food wholesalers who handle 775,000 tons of food. Average rentals of \$1.65 per square foot of space would be required to finance and operate the facilities. This is slightly higher than the current rents being paid, but the other savings more than offset this increase. About \$750,000 annually could be saved by relocation. The savings would result primarily from less handling, less cartage, and reduced waste and product spoilage.

It is proposed that only 61 of the operators who occupy a total of 660,000 square feet of space be relocated. These operators handle in excess of 90 percent of the products and would require about the same amount of space that they are currently occupying.

Eight operators have been relocated in two buildings which have been completed at this time. Planning is underway for additional construction in the immediate future as the site is ready for construction.

The Commonwealth's Department of Agriculture, Department of Commerce, and Experiment Station, as well as the U. S. Department of Commerce have cooperated in this research.

7. Baton Rouge, Louisiana. A report has been written and published on the restudy of the wholesale food marketing facilities in Baton Rouge at the request of the Louisiana Department of Agriculture. At the present time, because of the lack of enthusiasm on the part of wholesale operators, the apparent need and benefits that might be derived from improved facilities, improvements were not proposed for this city. The deterioration of the market and the lack of sufficient interest on the part of the wholesalers would cause a high element of risk which is too great to go forward with any recommendations for relocation. Substantial improvement is possible in individual facilities and should be promoted on an individual, rather than a group, basis.

B. Preliminary and followup work in terminal market areas.

Prior to any major study in a terminal market, investigations of an exploratory nature must be made to determine the nature and extent of the work to be done in order that personnel and resources can be allocated. In cities where studies have been completed or where work was terminated during the year, additional work is often required to assist the interested groups in financing, organization, construction, and management of improved facilities. In many areas it is necessary to perform additional work to insure proper operation and maximize any cost reductions possible. During the reporting period 14 cities received assistance under this program. Followup work, additional planning, and other assistance required to obtain the best possible combinations of facilities and operations were conducted in New York, Rochester, northern New Jersey, Philadelphia, Providence, Detroit, Boston, Milwaukee, Louisville, and Pittsburgh. Preliminary investigations were made in Baltimore, Kansas City, Minneapolis, and Montgomery.

1. Rochester, New York. At the request of the market management in Rochester, changes in the structure of one building was planned. Because of anticipated vacancies, part of one building currently being occupied by fruit and vegetable operators will be converted to meat operations. This will provide desirable diversification and also bring into the market a segment of the food industry which previously had not occupied facilities on the market.

2. New York, New York. Construction of improved facilities for handling fruits and vegetables is progressing at a good rate after some delays due to labor and other problems such as weather. Occupancy of this section of the proposed market is expected about mid-year 1965. Numerous consultations were held during the year with city officials, engineers, architects, and industry groups. Advice and assistance were provided on financing, layout, design, and relocation. Operators in the Washington Street market have been advised that condemnation proceedings will be sufficiently advanced by the

time moving plans are formulated that partial payment for the existing properties can be made by the city.

Preliminary plans have been submitted by the engineers, accepted and approved by the city for the relocation of the 14th Street and Brook Avenue markets for meat and poultry. Real estate and site acquisition are being planned, funds being allocated, and planning initiated for development of final plans for this important segment of the wholesale food-distribution facilities for the metropolitan New York area. In addition to these commodities, plans are also progressing on the relocation of the Fulton Fish market in the new market area at Hunts Point in the Bronx.

3. Northern New Jersey. Consultations were held with the personnel of the New Jersey public market commission, New Jersey State Department of Agriculture, and local groups of wholesale dealers in Newark, Jersey City, and other northern New Jersey communities regarding the possibility of constructing a modern food-distribution center in that area. Enthusiasm and interest on the part of these groups have resulted in several planning studies, none of which has been conducted by the Department. Marketing Facilities Planning Staff members will continue to provide technical assistance in planning wholesale food facilities to these groups as requested.

4. Philadelphia, Pennsylvania. Limited work was conducted by the Division in Philadelphia in the past year. Visits by personnel have been made in the nature of informal discussions of problems in operating practices and improvements that could be made. Continued visits to this market are expected to be made because it provides an excellent demonstration of what can be accomplished in this field and offers a valuable source of operating costs for usage in comparison of benefits that might be achieved in other cities.

A publication is being prepared on the creation of the food-distribution center by the management of the center and the city of Philadelphia has been invited to develop an exhibit of this facility as the only U. S. exhibit at the International Agricultural Exhibit in Paris next spring.

5. Providence, Rhode Island. Changes in the original proposals for improvements in the wholesale food handling operations were made during the year. Changes were necessitated because of changes in expressway relocation and urban renewal plans that were in the area planned for the development of a food-distribution facility complex.

6. Detroit, Michigan. During the year representatives of the Marketing Facilities Planning Staff met several times with the Detroit Common Council to advise and provide technical guidance in developing workable plans for increasing the efficiency of the wholesale food handling operations in the city. Plans were proposed as a result of our studies, but some difficulty has been encountered in getting combined action on any one or a combination of proposals presented in the report.

7. Boston, Massachusetts. Since the release of two of the three reports planned on Boston marketing facilities, followup work has been required on the development of plans for improved facilities for handling agricultural products in both Boston and New Bedford.

Redevelopment plans and changes in plans required reevaluation of the proposals for improving and handling and marketing of horticultural specialty crops in Boston.

Additional data were provided city officials in New Bedford in order that loan applications could be prepared and processed to secure public financing for part of the project in improving the facilities used for handling, processing, and marketing food in this Massachusetts community. Other work in Boston was reported in the section on terminal facilities.

8. Milwaukee, Wisconsin. Work was completed on this project during the year. Followup of the work in Milwaukee was transferred to the project covering this. Because the work was terminated near the end of the reporting period, no additional work of a followup nature has been required or requested to implement the findings of the study which was reported in the section on terminal facilities.

9. Louisville, Kentucky. Work was started in Louisville to ascertain the feasibility of cooling entire facilities for produce wholesalers. It was found that it is both feasible and desirable to intensify the use of refrigeration in the marketing of produce. The required investment can be repaid within a few years by reducing the spoilage rate. The intensified use of refrigeration permits more compact stacking and the maximum utilization of vertical height, which in turn reduces the requirement of floor space for a given volume. An air-door was developed, based on earlier work done by the Department, which makes the utilization of refrigeration feasible. Arrangements are being made for its manufacture and it will be available to anyone who wishes one.

The entirely refrigerated facility for handling fruits and vegetables at wholesale was demonstrated to market managers at their annual meeting in Louisville and was received enthusiastically. Several produce wholesalers are considering adopting the same method, which includes mechanical handling, pallet racks, and refrigeration.

Further work is being done to find the most economical construction and insulating method which could reduce further the required investment.

10. Pittsburgh, Pennsylvania. Work on Pittsburgh was transferred to this project late in the reporting period and as a result, no work of a preliminary or followup nature has been required.

11. Minneapolis, Minnesota, Baltimore, Maryland, Montgomery, Alabama, Kansas City, Missouri. Preliminary investigations have been completed and the

decision made that terminal studies in Baltimore are needed and that the co-operation and other required elements are sufficiently present to expect good results from studies there. One other study will be initiated early in 1965 and investigations are underway in the other three areas to determine the most effective study area. Selection will not be made until near the end of 1964.

12. Other activities relating to terminal market planning and preliminary and followup in terminal market areas. Studies of markets that have been constructed, or on which substantial improvements have been made, were started in 1962 in an effort to improve the planning of wholesale food marketing facilities. Information was obtained from the management of markets in Kansas City, Missouri, Louisville, Kentucky, Grand Rapids, Michigan, San Francisco, California, Jackson, Mississippi, Tampa, Jacksonville, Miami, and Sanford, Florida.

In order to be able to give up-to-date recommendations on facility planning, it is necessary to know the problems being encountered and how they are being solved in wholesale food marketing facilities that have been constructed since the early 1940's. General information concerning changes in volume handled, financial organization, building design, and operating methods have been collected in the markets of 13 cities.

The information obtained from the studies of the new and improved wholesale food marketing facilities is in the process of analysis and a report of the findings will be made that might be used by officials, industry groups, engineers, and others planning or contemplating planning improved marketing facilities for food.

C. Production area and independent market facilities planning.

During the year a total of 41 studies were made of production area and independent marketing facilities. These included 18 facilities for handling and marketing poultry and poultry products, 9 livestock and meat, 6 fruit and vegetable, and 8 wholesale grocery facilities. Numerous meetings were held with architects, engineers, equipment manufacturers, and other interested groups concerning specific problems on design, layout, capacities, location, and other features as they affected the construction of new or improved facilities.

1. Poultry and poultry products. Facilities for marketing poultry and poultry products must be located in the right places and they must be designed properly and operated efficiently if costs are to be reduced and held to a minimum.

This project is concerned with planning facilities for handling poultry and poultry products in areas where they are assembled, processed, graded, packaged, frozen, stored, shipped, or otherwise handled in preparation for retail marketing. Emphasis is placed on planning facilities that can serve

as a guide and stimulus to a number of firms and individuals interested in improving their own operations.

During the reporting period studies were made in the producing areas of Alabama, Arkansas, Georgia, Illinois, Louisiana, Massachusetts, Mississippi, New York, South Carolina, Virginia, and Tennessee. These studies included design for construction, layout, and operational systems necessary for efficiency in marketing poultry and eggs. Approximately 50 percent of the facilities planned are under construction or have been completed. Proposals are under consideration in several of the other facilities planned.

2. Livestock and meat. Assistance in planning improved facilities for handling livestock and meat was provided nine operators during the reporting period. Assistance included work on planning live animal facilities in two locations, planning additions to three facilities for processing and handling meat, and four facilities for slaughtering livestock. In addition, specialized assistance was rendered on all terminal markets where the handling of meat and meat products was involved.

Assistance was provided four engineering firms that requested special assistance in developing meat processing facilities during the year.

Primary emphasis was placed on the wholesale meat handling facilities in and around Chicago, Illinois. The changes in the meat packing industry are farther advanced in this area than in any other major market in the country. The problems being encountered in the terminal study will require special study prior to the publication of the report on Chicago. Undoubtedly, the problems facing the stockyards area in Chicago are being felt in other parts of the country where major terminal markets for livestock are located. No definite conclusions or recommendations have been reached on this investigation and planning to date.

3. Fruit and vegetable. The planning of centralized apple packing and storage facilities for two areas in Wisconsin and one in Illinois were conducted during the year. Principal objectives in each case were to design the market facilities and to devise the operating methods that would most effectively serve the needs of the several producers in these respective areas who wish to associate in a corporate enterprise. Apple storage planning assistance was also extended to individual producers in locations too remote from the proposed centralized facilities. Two other planning studies of wholesale facilities for handling fruits and vegetables were conducted during the year.

In discharging the Department's responsibility as certifying agency to the Area Redevelopment Administration on agri-business projects, several loan applications on proposed fruit and vegetable facilities were reviewed. These included a \$1.4 million expansion of potato processing operations in Maine to provide additional raw product conditioning space and frozen

storage capacity, the construction of a half-million dollar apple and peach packing and storage house in South Carolina, and a small packinghouse in the new peach producing area of north Florida.

Toward the close of the year, work was begun on assisting a cooperative organization in Mississippi plan and develop a layout of a vegetable canning and freezing plant involving a total investment in excess of two million dollars. This project is being financed exclusively by funds from within the State and should contribute materially to the betterment of the economy within the supply area of the plant.

4. Grocery warehousing. Operational and planning assistance was given to eight individual firms. Studies of operating procedures were made in two of these. In two other firms, studies were made of the feasibility of moving into different facilities. Interior layouts were designed for two of the firms, while existing plans were evaluated for two others.

Several educational and extension projects were carried on in connection with the work on planning grocery handling facilities during the year. A presentation on planning a new warehousing operation was made to the Dry Grocery Redevelopment Committee for the Faneuil Hall area of Boston. Other industry presentations on grocery wholesaling were made to the Institutional Food Distributors Association convention, the Texas Wholesale Grocers convention, and the Food Service Executives Association, Inc. of Baltimore. A demonstrational study for New York Extension Service and State Department of Markets personnel was conducted. In addition, presentations were made to food distribution conferences of the Florida Extension Service and the Michigan State University.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Terminal Wholesale Market Planning

- Holland, R. L. 1964. Food center suggested for San Juan. The San Juan Star, San Juan, Puerto Rico, May 13, 1964. p. 9.
- Overheim, R. K. 1964. Baton Rouge wholesale food-distribution facilities. Agr. Marketing Ser. No. 536. 11 pp.
- Overheim, R. K. 1964. Milwaukee wholesale fresh fruit and vegetable market facilities. Marketing Res. Report No. 664. 50 pp.
- Todd, F. R., Jr. 1964. Pittsburgh wholesale food-distribution facilities. Marketing Res. Report No. 660.
- Todd, F. R., Jr. 1964. The Louisville Produce Terminal -- First successful combination of several cost-reducing innovations. Agr. Marketing, March 1964. 3 pp.
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Production Area and Independent Marketing Facilities

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AREA 2

DAIRY PRODUCTS - MARKETING FACILITIES EQUIPMENT, AND METHODS

Problem. A survey of market milk and ice cream plants throughout the country, by the University of Illinois in 1958, shows that the equipment, work methods, and facilities of many of these plants are obsolete and the production per man-hour employed relatively low. A major factor contributing to this obsolescence is the development during the last few years of new types of equipment which can be brought under automatic control. Because of the investment required and the uncertainties of the returns they would obtain, plant operators have been reluctant to shift to automated equipment on a piecemeal basis. They also have been reluctant to build new plants because of a lack of guidelines and criteria on automated plants. However, studies indicate that it is possible in fully automated plants to increase the productivity of labor 100 percent or more, to improve the qualities of the finished products, and to develop better management-employee relations. Engineering layouts and operating criteria therefore are needed for automated plants to provide guides to plant operators in making the shift from their present equipment and facilities. Most dairy plants lack the technological and engineering skills necessary to plan and develop suitable plant layouts and designs, or to select the types of equipment needed and the controls necessary for full automation. Automated equipment and processes for some types of dairy plants still largely are lacking or are nonexistent. Therefore, engineering research also is needed to develop equipment and processes for automating these plants in order to increase labor productivity and improve product quality.

USDA AND COOPERATIVE PROGRAM

The Department has a continuing long-term research program involving agricultural engineers and dairy technologists engaged in applied research to develop improved methods, equipment, operating criteria, and plant layouts for dairy plant operators.

Current research covers the development of layouts and operating criteria, based on current technology, for automated dairy product plants. It features the use of remotely operated valves, electronic-controlled devices, and highly mechanized equipment. Work in the Hyattsville office consists of checking, organizing, and preparing for publication a series of reports prepared under contract.

The Federal effort devoted to research in this area during the fiscal year 1964 was 0.9 man-year; 0.5 man-year for direct work (this employee was enrolled at the University of Minnesota for full-time training in dairy technology) and 0.4 man-year for program leadership.

PROGRESS - USDA AND COOPERATIVE PROGRAMS

A. Layouts and Operating Criteria for Automated Dairy Product Plants

At Hyattsville, Md., work was continued on the preparation for Department publication of a series of contract reports covering the development of layouts and operating criteria for different types of automated dairy product plants. Two of the six contract reports were published last year. The status of the work on the four remaining reports in this series is as follows:

1. Plants Manufacturing Ice Cream and Ice Cream Novelties. At the end of the report year, the contractor's report had been checked, reorganized, and a revised draft for Department publication was about 85 percent completed. The significant results of this study were reported last year.
2. Plants Manufacturing Cottage Cheese, Cream Cheese, and Cultured Milk and Cream. A report for Department publication prepared from the contractor's report is about 50 percent completed. Results of this study were reported last year.
3. Plants Manufacturing Cheddar Cheese. The contractor's report covering layouts and operating criteria for automated and highly mechanized cheddar cheese plants shows that a plant handling 800,000 pounds of milk weekly can reduce its labor force from 43 workers to 22 workers and labor cost from \$279,500 to \$143,000. The use of automated equipment and an improved layout makes it possible to increase labor productivity from 45 pounds of cheddar cheese per man-hour to 88 pounds per man-hour.
4. Sweet Cream Butter and Dried Nonfat Milk. Department work on this contract report has not progressed to the stage where significant findings can be summarized.

PUBLICATIONS - USDA AND COOPERATIVE PROGRAMS

None.

AREA 3

FIELD CROPS - MARKETING FACILITIES EQUIPMENT AND METHODS

Problem. Differences in varieties of individual field crops and in the environments of producing areas where they are conditioned and stored, together with advancing techniques in cultural and harvesting practices, require new or modified marketing facilities, equipment, and methods. Such changes are essential to the efficient and economical handling, conditioning, and storing of these crops and to maintaining their quality. There is a need for improved designs for facilities based on functional and structural requirements, which will expedite the movement of commodities into, within, and out of the facility. There is also a need for handling and conditioning equipment which will minimize labor and other costs. More knowledge is needed of the relative efficiency of various handling and conditioning methods so that improved or revised methods and equipment can be developed to perform necessary operations.

USDA AND COOPERATIVE PROGRAM

The Department has a long-term program involving agricultural engineers and industrial engineers engaged in both applied and basic research on, as well as application of known principles to, the solution of problems of handling, storing, and conditioning field crops in marketing channels. Grain aeration and drying research is carried out at Manhattan, Kans., on wheat and grain sorghum; at Lafayette, Ind., on corn, in laboratory and pilot-scale facilities and in commercial storages; in cooperation with the Agricultural Experiment Stations of Kansas and Indiana and with grain storage firms. Cooperative research on grain is supplemented by a research contract with the Airfoil Impellers Corporation, College Station, Tex. Research on the design of grain storage structures is conducted at Hyattsville, Md., with field studies providing the basis for selecting capacity and type of operation. Research on the handling of grain in country elevators and terminal storages is conducted by the Manhattan, Kans., field office in cooperation with the Kansas Station. Studies of grain storage in CCC bins are conducted at a research bin site at Watseka, Ill. Research on the handling of cotton bales and humidification of storage compartments is conducted at Bakersfield, Calif., in cooperation with Calcot, Ltd., at selected warehouses in California and Arizona. Research on the handling, drying, aerating, storing, and shelling of peanuts is conducted by the Albany, Ga., field office at laboratory and pilot-scale facilities in Dawson and Bainbridge, Ga., in cooperation with the Georgia Agricultural Experiment Stations, and with

various industry firms. Studies on the handling, drying, aerating, and storing of rice are conducted at Beaumont, Tex., in cooperation with the Texas Agricultural Experiment Station and at commercial facilities in Texas, Arkansas, Louisiana, and Mississippi. Research on aeration and storage of cottonseed is conducted at Stoneville, Miss., in cooperation with the Mississippi Station and at commercial facilities in Mississippi.

The Federal effort devoted to research in this area during the fiscal year 1964 totaled 17.4 professional man-years: 4.2 to grain aeration and drying; 0.8 to the design of grain storage structures; 0.9 to the handling of grain in terminal storages; 1.5 to studies of grain storage in CCC bins; 1.0 to the handling of bales of cotton and to the humidification of cotton storage compartments; 4.0 to the handling, drying, aerating, storing, and shelling of peanuts; 2.0 to the handling, drying, aerating, and storing of rice; 1.0 to the aeration and storage of cottonseed; and 2.0 to program leadership.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Aeration and Storage of Cottonseed

At Stoneville, Miss., studies were continued in both commercial storages and in the laboratory to determine the usefulness of aeration for maintaining the quality of cottonseed in storage for both short term and long term storage. The studies include the determination of satisfactory airflow rates, equipment requirements, size and location of ducts, operating schedules, and labor requirements for aerating stored cottonseed.

During the 1963-64 storage season one improved aeration system was designed and installed in a cooperating commercial storage. With the improved system less than one fourth the electric power used the previous season in the same storage was required to move more air through more cottonseed and at a greater depth. A part of the improved system was an aeration duct having a greater percentage of surface area that limited the velocity of the air moving through the cottonseed and into the ducts. This increased surface area was responsible for a major reduction in static pressure losses in the cottonseed around the duct. This, plus the use of more efficient fans and well designed air supply systems, was responsible for most of the increase in the performance efficiency of the improved aeration system.

Laboratory studies were initiated to determine the effects of different duct surface areas and materials and of compaction of stored cottonseed on static pressure losses when moving air through the seed. One series of tests was conducted using two types of duct sections and air velocities of 5, 10, 15, 20, and 25 feet per minute at the duct surfaces. These limited tests indicate that both the type and area of duct surface affect the static pressure losses in the seed immediately surrounding the duct.

Studies of the small-scale aeration system installed last year were continued. The data obtained were too limited to indicate any definite cooling rates for the airflow rates used--1/10, 1/5, 1/3, and 1/2 cfm per cubic foot of cottonseed. When cottonseed having an initial moisture content of about 8 percent was aerated with air at relative humidities above 75 percent and temperatures below 55°F., its moisture content was increased about 1 1/2 percent.

B. Shelling, Handling, Drying, Aerating, and Storing Peanuts

1. Shelling. About 160 tons of Spanish-, Runner-, and Virginia-type peanuts were shelled in the experimental shelling plant at Dawson, Ga., during the 1963-64 shelling season. Peanuts were obtained for the tests from the Southwest, Southeast, and Virginia-Carolina producing areas.

Sheller speeds between 215 to 245 RPM were superior for shelling Virginia-type peanuts with Medley shellers when shellers were operated over a total range of 175 to 325 RPM. These results substantiated those of shelling tests on Virginia-type peanuts from the 1962-63 season. Spanish-type peanuts were shelled using both a Medley sheller and a basket-type grate. The Medley sheller caused the least mechanical damage when operated at 225 RPM; the basket-type grate when operated at 185 RPM. The two types of shellers appeared to be about equal in rate of shelling. Only the Medley sheller was used to shell Runner-type peanuts and shelling speeds from 215 to 235 RPM caused the least mechanical damage.

Results of research during two seasons indicate that the speed of Medley shellers should not exceed 225 RPM for Spanish-, 235 RPM for Runner-, and 245 RPM for Virginia-type peanuts. Limited tests also indicate that the Medley (grate-type) sheller and the basket-type sheller are about equal in shelling performance when each is operated at its optimum speed which generally will be different for each sheller.

Motion pictures of the shelling action of conventional shellers indicated that shelling is caused by pressure applied to the shells rather than by stirring action; also, that only about three-fourths of the grate surface in a Medley sheller is in use during shelling.

Cleaning.--Some progress was made toward improving the performance of the Simon-Carter scalperator for cleaning farmers stock peanuts. This equipment, while removing an acceptable proportion of the foreign material, also removed a relatively high percentage of peanuts. Cleaning equipment was developed that substantially reduces the number of peanuts removed with the foreign material, but further adjustments and refinements are needed for removing a larger percentage of foreign material. The results and ideas gained from the tests need further application to actual cleaning operations.

Presizing.--Sizing tests were run to determine the number of size-groupings of farmers stock peanuts required for optimum shelling operations. Results indicate that it is possible to separate the general run of Spanish- and Runner-type peanuts into about 4 size-groupings for shelling. Tests were run on only one variety of Virginia peanuts, NC-2, and additional data are needed on other varieties of this type.

2. Handling. Results of continuing tests with the pneumatic conveyor at Bainbridge, Ga., showed that mechanical damage totaled 8 percent for Spanish-, 33 percent for Virginia-, and 10 percent for Runner-type when peanuts were elevated about 30 feet and dropped into a bin. Limited tests on moving peanuts horizontally with the pneumatic conveyor indicated this method to be more costly than the common method of shoveling peanuts onto a belt conveyor. Feeding peanuts into the pneumatic system from a stored pile was both time consuming and laborious and resulted in a lower handling rate than the system using a belt conveyor.

Tests with conventional bucket elevators indicated that a 12-inch spacing of buckets was superior to a 6-inch spacing for elevating farmers stock peanuts. Although mechanical damage was not significant with either spacing, the 12-inch spacing gave a higher elevating rate.

3. Drying. A total of 81 drying tests with Spanish-, Runner-, and Virginia-type peanuts were run in the experimental pilot-scale drying unit at Bainbridge, Ga., during the 1963 drying season. Two new drying treatments were studied consisting of alternate heating and cooling during the drying process, one with the airflow direction alternated every 2 hours, the other, every hour. These two treatments were compared with a third treatment using continuous heated air moved alternately upward through the bed of peanuts for one hour and then downward for one hour. Heated air temperatures of 125°, 135°, and 145°F. were used with each drying method.

The two new drying treatments were superior to the continuous heat treatment from the standpoint of the amount of mechanical damage to the peanuts that occurred during the shelling process. Each of the two treatments required about one-third as much fuel as the continuous heat method but about one-third more time in the dryer.

Samples of peanuts from each drying test were analyzed to determine the effects of each treatment on peanut taste, splitting, and skin slippage. The number of split kernels were not significantly different in samples from peanuts dried with alternate heating and cooling with the drying air at 135° and 145°F. than in samples from peanuts dried with continuous heating with drying air at 125°F. Results indicate that other quality factors react similarly to various drying treatments. Results to date are not conclusive and drying studies are being continued to determine optimum

time-temperature relationships for drying peanuts to obtain the prompt reduction of moisture to minimize mold infection--considered vital in preventing aflatoxin contamination--while maintaining desirable qualities of taste, appearance, etc., of the dried peanuts.

4. Aeration. Tests with stored farmers stock peanuts were continued at Bainbridge, Columbus, and Dawson, Ga.

A total of 865 tons of Spanish-type peanuts stored in an aerated silo at Columbus lost less than 1 percent moisture during the 7-months storage period. The aerated peanuts had a considerably lighter colored skin than peanuts stored with no aeration. Apparently consumers of salted nuts prefer peanuts having the lighter colored skins, so these research results are of particular interest to processors. As a result of this research, the storage firm at Columbus has installed additional aeration equipment.

At Bainbridge, peanuts increased 1.3 percent in moisture during 4 months of aerated storage. At Dawson, Ga., peanuts also increased about 1 percent in moisture during 3 months of aerated storage. These peanuts appeared to shell better at the higher moisture content with somewhat fewer split kernels. An additional benefit was the added weight, which, at the prevailing market price, amounted to an increase of some \$2.50 per ton of peanuts stored.

C. Handling Grain in Country Elevators and Terminal Storages

At Manhattan, Kans., a report, "Loading Boxcars at Country Elevators in the Hard Winter Wheat Area," was prepared for publication. The report includes the results of the 7 loading methods studied and discusses more efficient work methods developed to shorten the time required in each of these methods. For example, the observed time for the fastest of the 7 loading methods studied was 52 minutes. The faster time developed from the research results for this method was 35 minutes, a saving of 17 minutes per car loaded. Three boxcars could be loaded in the time required to load two cars by use of the observed method, and with the same 2-man crew. Faster loading of boxcars is particularly important at harvesttime when bins must be emptied rapidly to make room for incoming grain. The study was made at elevators in Kansas, Nebraska, Missouri, Oklahoma, Colorado, and Texas.

Information is needed as to what part of the physical damage, in the form of broken kernels, is due to the handling equipment and procedures used in moving grain through marketing channels. Therefore, limited work was initiated in 1964 to obtain data on the percentage of shrunken and broken kernels in new harvest wheat received at country elevators in Kansas. Eleven test bins were filled and the amount of shrunken and broken kernels in this wheat ranged from 0.8 percent to 3.2 percent. Additional samples will be obtained for further analysis when this wheat is moved from the test bins.

In a continuing study, new wheat from the 1963 harvest was used to determine the amount of cooling accomplished during turning operations. Grain temperatures at the center of the bin averaged 100°F. in July 1963. In November; after double turns in July, August, and November; these temperatures averaged 78°F. The wheat was again double-turned in January. Before turning grain temperatures at the bin center averaged 76°F.; after turning 53°F; a difference of 23 degrees. Maximum cooling was accomplished by turning the wheat after an intense cold snap rather than during a cold snap, which is more customary. During March, the changes in temperature of the grain 1 foot inward from the wall averaged less than 1.5°F. per week; 10 feet inward, the changes averaged less than 0.5°F. per week.

D. Grain Aeration and Drying

1. Drying. At Lafayette, Ind., full-scale tests with a new drying process called dryeration confirmed results of earlier exploratory tests that substantial increases in drying capacity could be obtained without sacrificing quality when drying shelled corn. Dryeration--a combination of drying and aeration--is applicable to both batch and continuous-flow drying systems.

The dryeration process incorporates three practices that reduce damage to corn from artificial drying. These are: (1) Dry in the usual manner but stop rapid or heat drying at the 16 to 18 percent moisture level; (2) transfer hot corn to dryeration bin (temporary storage bin equipped with aeration) and allow the hot corn to temper and steam itself before cooling; and (3) cool the corn slowly overnight with an airflow rate of 1/2 cfm per bushel. Removing the corn from the dryer at 16 to 18 percent moisture permits the use of higher drying air temperatures without accompanying increases in grain temperature. Also, rapid drying is stopped before the corn becomes overly brittle and subject to breakage. The stresses caused by rapid drying are relaxed during the tempering period and the slow cooling avoids additional stress from rapid temperature changes in the corn. Corn moisture is further reduced by 1 to 2 percent while corn is being cooled in the dryeration bin.

The full-scale drying tests were continued in the fall of 1963 in the continuous-flow dryer at Lafayette, Ind. The cooling section of the dryer was converted for drying and the dryeration process used in all tests. When the dried corn was cooled slowly following a tempering period, stress cracks and breakage were reduced by one half as compared to conventional cooling. Drying air temperatures of 240°F. caused no appreciable deterioration in wet milling quality. When corn having an initial moisture content of 25 percent was dried at an air temperature of 290°F., the milling quality was reduced, particularly when dried to 16 percent moisture and below. The capacity of the dryer was nearly doubled by switching from conventional continuous-flow drying and cooling to the dryeration process when drying corn having 25 percent moisture to safe storage levels.

Millers and processors are interested in dryeration because the delayed cooling and tempering period included in the process promises a better quality product. Dryer operators are also interested, not only from the quality standpoint, but because of the increased capacity that is possible. Because of this widespread interest a progress report was published in April 1964 explaining the dryeration process and giving results obtained to date. However, further research on the process is underway.

The Humidex process for detecting heat damage in corn caused by artificial drying--based on changed hygroscopic properties that take place--was used on samples from 1963 field drying tests and on 30 specially prepared samples from 24 different corn hybrids. Variations in Humidex readings among the 24 varieties dried in a uniform manner were not much greater than variations among samples from the same variety. Of the special types of corn tested, white corn and amylose corn seem to have hygroscopic properties differing from those of ordinary yellow dent corn, while waxy varieties have similar properties. Unexplained variations in Humidex readings are the subject of continued study. At present, the process is about 90 percent effective in detecting heat damaged corn.

Through the use of digital computers, mathematical expressions were developed to represent thin-layer drying of corn at temperatures up to 500°F. The relationships used were based on results of thin-layer corn drying tests conducted in the laboratory. A mathematical expression for the equilibrium moisture content of corn exposed to air at different temperatures and relative humidities was revised to bring it more in line with published experimental data. A mathematical model was then developed to simulate cross-flow or batch drying and programmed for computer analysis. The results from the simulated tests checked closely with those from limited laboratory tests. The computer program was revised to simulate drying in a continuous-flow dryer where the air and grain move concurrently. Results from over 120 "drying tests" with the computer indicate probable drying efficiencies in the 70 to 80 percent range and the possibility of some quality advantages with this method of drying.

A laboratory dryer is under development for use in the fall of 1964 to check the results of the concurrent-flow simulation tests and to generate samples for quality evaluation.

MRR No. 631, "Stress Cracks and Breakage in Artificially Dried Corn," was published to replace AMS No. 434, "Stress Cracks in Artificially Dried Corn." This new publication reports recent research findings on both the formation of stress cracks and the increased breakage susceptibility in artificially dried corn.

At Manhattan, Kans., encouraging results are being obtained from research initiated in 1963 to develop and test crossflow ventilation systems for conditioning moist grain in deep storages. The newly developed system was

tested using three lots of 1964-crop wheat and four lots of 1963-crop grain sorghum. Promising features of this system design include satisfactory installation and maintenance of vertical aeration ducts on the walls of deep concrete bins; adequate distribution of air throughout grain 110 to 120 feet deep; an airflow rate and cooling rate about 8 to 10 times the normal rates for a bin of the same size equipped with a floor-duct system; and acceptable use of vane-axial type fans with lower power requirements.

New crop wheat having 14.2 percent moisture and grading No. 1 HW (tough) was used in one test. After 124 hours of ventilation the moisture content was reduced to 13.3 percent and the wheat graded No. 1 HW. It was calculated that 7 tons of water were removed during the test. Grain temperatures were lowered from an initial average of 92°F. (range 84° to 95°F.) to a final average of 82°F. (range 80° to 84°F.). In another test the crossflow bin was filled with new crop wheat and aerated continuously for 24 hours. The initial grain temperatures averaged 92.5°F. (range 82° to 104°F.). After 24 hours of aeration, the wheat temperatures averaged 84°F. (range 76° to 92°F.), an average reduction of some 8.5°F. This rate of cooling is much faster than that accomplished in conventional type aeration systems where aeration ducts are located on the floors of deep bins.

2. Aeration. At Manhattan, Kans., field studies were continued on a limited basis in commercial storages, both flat and upright.

Two aerated test bins at Abilene containing wheat from the 1958 crop were unloaded during the year. This wheat had not been moved in 5 1/2 years but had been aerated during each of the 6 winters. Final composite samples graded No. 1 HW, the same as when placed in the bins in 1958. The wheat lost only 0.6 to 0.7 percent moisture during the 5 1/2 years of storage.

Grain sorghum under study in a flat storage, 100 by 361 feet, developed serious surface crusting and spoilage over most of the center-peaked area with heating extending 3 feet below the grain surface. This condition developed during November, December, and January before aeration was started. Heating and further deterioration was stopped by aerating the wheat during February and March plus some shoveling and mixing of the wheat throughout the crusted area. Up to 30 percent damage was found in samples submitted for official grade. Moisture migration caused an increase in moisture content of the surface grain from 11 percent up to as high as 16.5 percent during storage for 3 winter months without aeration.

Official grades obtained from wheat stored in cooperating elevators having the annex bins fitted with combined aeration and dust control systems showed excellent grain quality maintenance. The average temperature of the new wheat was reduced to below 40°F. which reduced the problems of sanitation and insect control.

A final report was prepared on the use of fans for reducing the temperature of the air in the headspace (space above the grain) and at the grain surface in large flat storages during summer months and this report is being submitted for clearance for publication. Headspace air temperatures as high as 140°F. were observed in storages with no fan ventilation while temperatures were from 20 to 40 degrees lower in similar storages equipped for fan ventilation.

At College Station, Tex., work was completed on a research contract to determine static pressure losses in aeration ducts of various sizes, losses from abrupt changes in duct sizes, and changes in static pressures through grain near the duct. Data from the contract report are being analyzed for use in preparing a published report on the results of the study.

E. Design of Grain Storage Structures

A study involving the use of queuing models of operations research to determine the optimal capacity of truck receiving facilities for country grain elevators was completed. Most of the work done during the report period was confined to the writing, editing, and publication of Marketing Research Report No. 671, "Selecting the Best Capacity of Truck Receiving Facilities for Country Grain Elevators."

Some additional work was done on the relationship between dump pit sizes and bucket elevator capacities. The purpose of this research is to find the lowest cost pit-elevator combinations for different receiving capacities. No final conclusions have been reached as yet. Also a report is being prepared for publication on the layout and design of large country elevators of concrete construction in which a systems-engineering approach is used.

F. Handling, Drying, Aerating, and Storing Rice

1. Handling. A survey was made of handling and operating methods and equipment used at commercial rice dryers in Texas, Arkansas, and Louisiana, by interviewing managers and dryer operators at 80 establishments. Operating methods varied widely, but in general, higher drying air temperatures were used in Texas and Louisiana than in Arkansas. About 80 percent of the dryers included in the survey used aeration. No operator reported replacing a complete drying unit because it had worn out though some of these units had been in operation since 1944. However, individual parts, such as top baffles in column dryers, were replaced from time to time. The most common charges for drying rice were 50 cents a barrel in Texas and Louisiana and 12.5 cents a bushel in Arkansas (45 cents a barrel).

Studies of handling and operating methods were made at selected dryers during the harvest season in 1963. The study indicated that the drying capacity at one dryer could be increased 30 percent by using somewhat higher drying air temperatures and by making full use of aeration for removing moisture between dryer passes.

2. Drying. Rice drying tests were continued at Beaumont, Tex., during the harvest seasons of 1963 and 1964. Both a pilot-size, continuous-flow, heated air dryer, and a laboratory dryer were used. Replicated tests in 1963 showed that the use of a faster rate of flow of rice through the dryer (throughput rate) and the adjustment of the heated air temperature to maintain a constant temperature of the rice leaving the dryer resulted in less dryer operation time and better milling yields of the dried rice. In these tests, increasing the throughput rate by 66 percent reduced the drying time by 30 percent and increased the milling yield by an average of 1 percent.

Tests were run during the 1964 harvest season to determine the effect of the saturation deficit--the difference between the saturated vapor-pressure at the dew point and at the dry bulb temperature of the air--of the heated air upon rate of drying, milling yield, and germination. The results of these tests have not yet been analyzed.

3. Rice Aeration and Storage Tests. The study of aeration of dry rice during winter storage was continued at Beaumont to obtain additional information concerning satisfactory operating procedures for controlling changes in moisture content. In one test, rice moisture dropped 1.1 percent when aerated with air having a relative humidity of 60 percent or less and with sufficient fan operation to move 28 cooling zones through the stored rice. In another test, rice moisture increased 0.3 percent when aerated with air having a relative humidity of 70 percent or higher and with sufficient fan operation to move 23 cooling zones through the rice.

The study of aeration for maintaining the quality of undried (green) rice was continued. When aerated at a rate of 1 cfm per barrel, Nato rice initially at 22.7 percent moisture content was maintained at grade No. 1 for 3 days and TP 49 rice initially at 21.9 percent was maintained at grade No. 1 for 7 days. A test was made with Belle Patna rice at 22 percent moisture content but the results have not been analyzed.

G. Handling Cotton Bales and Humidifying Storage Compartments

1. Handling Cotton Bales. At Bakersfield, Calif., studies were continued on the use of 10,000-pound clamp trucks for unloading bales from one side of a road truck. With flat bales loaded 2 high on head on a truck, one 10,000-pound clamp truck carrying 12 bales per trip can unload 100 bales

and set them in row blocks ready for tagging, sampling, and weighing in 20 minutes. This is a saving of around 15 minutes over the next best method where a 4,000-pound clamp truck is used. Some states do not permit road trucks to travel with bales stacked 2 high on head, but require that the top tiers be in a horizontal position. Therefore, studies are being continued to develop unloading methods for the required loading patterns.

The installation of equipment was not completed for the study of the electronic transmission of bale weights, etc., so tests could not be initiated during this reporting period.

Limited observations of conveyors used for moving bales from the dinky press to the compress indicated that production was relatively low and maintenance costs relatively high. Additional work is planned for this phase of bale handling operations.

The report comparing the use of tractor-trailer trains and 10,000- and 18,000-pound clamp trucks for transporting bales was submitted for clearance for publication.

Two reports were published during the year. "Weighing Bales of Cotton at the Compress" compares an electronic scale in combination with an automatic dinky press feeder with two current methods using portable platform scales. "Increasing Storage Capacity in Older Cotton Warehouses" suggests ways of modifying layouts and stacking patterns in old warehouses to increase their capacity and to make it possible to use modern handling methods.

2. Humidifying Storage Compartments. At Bakersfield, Calif., research was initiated to determine the feasibility of humidifying storage compartments to maintain the moisture content of stored bales of cotton at a desired level and to minimize the normal loss of moisture which increases the brittleness of the cotton fibers. Bales having an initial moisture content of about 5 percent were stacked in three patterns in a controlled test room and in a compartment with some humidification. Relative humidity of the air in the control room was maintained at 80 percent, corresponding to cotton moisture of about 8 percent. During the winter with outside temperatures between 38° and 50°F., the moisture content of bales, in both the control room and the compartment, reached 7 percent in 30 days and 8 percent 20 days later. This moisture level was maintained for 200 storage days in the compartment, or until the outside air temperature rose to 90°F. and humidity lowered to 15 percent, at which time compartment humidifiers were operated continuously. This resulted in the compartment bales increasing to 8.5 percent moisture content, then reducing sharply to 6.5 percent as temperatures rose to 100°F. Bales in the control room remained at about 8 percent moisture during the test period. In both the test room and the compartment, changes in moisture at the center of the bale lagged changes

near the surface by 2 to 3 weeks. Bale stacking patterns showed only a slight effect on moisture change. Bales in the control room followed the same trend in moisture change regardless of bale density or storage position, however the rate of change was faster in low density bales. Studies will be continued using various bale coverings and stacking patterns and cotton of identical history. Tests on the effect of humidification on cotton quality will be included.

H. Studies of Grain Stored in CCC Bins

At Watseka, Ill., tests were continued into the second year on storing unblended shelled corn in 8 aerated flat storages where fans were operated as blowers on one half the storages and as exhausters on the others. The amount, and location, of changes in moisture content of the corn closely followed the pattern established the first storage year. Again, increases in moisture content were slightly less in corn aerated by fans operated as blowers than in corn aerated by exhausting. After 1 year of storage, the average total damage in corn aerated by blowing had increased 1.7 percent and by exhausting, 2.7 percent.

Tests of the effect of various fan operating schedules on shelled corn stored in standard USDA bins were continued. Total damage increased only 1.2 percent in 4 years when airflow direction was alternated while increasing 4.0 percent when airflow was continuous in one direction. The tests were replicated with different crop year corn and after one year's operation, alternate aeration resulted in an average increase of 1.0 percent in total damage, only slightly better than continuous aeration which resulted in a 1.1 percent increase.

Unexplained increases in moisture content of corn stored in aerated standard bins led to full-scale tests on warming shelled corn which had been winter-cooled. Results from the second year's tests again showed that corn in the lower portions of the bin increased about 1 percent in moisture content when warmed from 30°F. to over 80°F. with continuous aeration. Extensive sampling indicated the highest increases in the warmest portions of the corn mass. Such increases raised the moisture content of several large areas of corn to over 14 percent. This combination of corn moisture and temperature led to a rapid increase in corn deterioration.

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AREA 4

HORTICULTURAL CROPS - MARKETING FACILITIES, EQUIPMENT AND METHODS

Problem. Returns to producers and prices paid by consumers for horticultural crops are adversely affected by the use of inefficient marketing facilities, equipment, and methods. Better work methods, techniques, devices, operating procedures, equipment, and facility designs are needed for precooling, conditioning, storing, handling, cleaning, washing, waxing, sorting, sizing and packing potatoes, citrus fruits, deciduous fruits, vegetables, and other horticultural crops. Such improvements are needed at both shipping points and terminal markets. They would increase the productivity of labor, prolong the storage life of the commodities, reduce bruises and injuries to these products, reduce marketing costs, expand consumption, and reflect greater returns to producers.

USDA AND COOPERATIVE PROGRAM

This is a continuing long-range research program covering the development of improved work methods, techniques, devices, operating procedures, equipment, and facility designs for precooling, conditioning, storing, handling, cleaning, washing, waxing, sorting, sizing and packing potatoes, citrus fruits, deciduous fruits, vegetables, and other horticultural crops. Potato research is carried on at the Red River Valley Potato Research Center, East Grand Forks, Minn.; the Potato Handling Research Center, Presque Isle, Me.; a field office at Gainesville, Fla., and the Hyattsville, Md., office; in both laboratory and commercially owned facilities; in cooperation with the North Dakota, Minnesota, Maine, and Florida Agricultural Experiment Stations, the Red River Valley Potato Growers' Association, the Market Quality Research Division, the Agricultural Engineering Research Division, the Marketing Economics Division of ERS, and the Forest Products Laboratory of the Forest Service. Citrus fruit research is carried on by field offices at Gainesville, Fla., and Athens, Ga., in cooperation with the Florida Agricultural Experiment Station, the Agricultural Engineering Research Division, the Market Quality Research Division, and commercial packers. Deciduous fruit research is carried on by the Wenatchee, Wash., and Athens, Ga., field offices and by the Hyattsville office; in both laboratory and commercially owned facilities; in cooperation with the Washington and Georgia Agricultural Experiment Stations, and the Market Quality Research Division. In Michigan research on deciduous fruits is conducted under a cooperative agreement with the Michigan Station. Vegetable research is conducted by the Hyattsville office at both terminal markets and at shipping points. The Gainesville, Fla., and Athens, Ga., field offices also conduct work at shipping points, in commercial packing plants and in laboratory facilities of the University of Florida. Work at

shipping points is in cooperation with the Florida and Georgia Agricultural Experiment Stations, and with the Market Quality Research Division. Sweet-potato work in North Carolina is conducted under a cooperative agreement with the North Carolina Station. Work on terminal markets, covering the wholesale distribution, is conducted by the Hyattsville office in the warehouses of selected fruit and vegetable wholesalers.

The Federal effort devoted to research in this area during the fiscal year 1964 totaled 12.3 professional man-years; 4.3 to potatoes; 2.4 to citrus fruits; 3.0 to deciduous fruits; 1.3 to vegetables; and 1.3 to program leadership.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Handling, Degreening, and Packing Citrus Fruit

This research, at Gainesville, Fla., is directed toward developing improved methods, devices, equipment, and facilities for conditioning, handling, and packing citrus fruits at Florida shipping points.

Three degreening test runs were made during the season on the early crop varieties of oranges, which are degreened from October through December. For each test the fruit was separated into the following color classifications: (1) Dark-green; (2) medium-color; (3) light-color; and (4) unsorted; which was taken at random from field-run fruit and used as a check. Degreening period was 84 hours, and fruit color was rated at 12-hour intervals except for the unsorted group which was color rated only before and after degreening. Color classifications were visual and all were made by the same person, using color plates as a guide. Based on the color rating of the fruit in the check lot before degreening, and the performance of fruit of the same color ratings in the dark-, medium-, and light-color lots during degreening, it was estimated that over 75 percent of the fruit in the unsorted check lot would reach passing color in about 48 hours. Therefore, the equivalent degreening time per box of this fruit need only be 57 hours. Based on an 84-hour standard versus a 57-hour degreening period and presorting for color, the time required in the degreening room for the majority of fruit could be lowered by 32 percent. This reduction in degreening time could increase the capacity of degreening facilities by 45 percent, which could amount to over 4 million 90-pound box equivalents a year during the October to January marketing period.

Additional data and information were obtained on complete commercial-scale pallet box handling systems; including labor and equipment inputs for fork-lift truck and box dumping operations at the packing plant and for grove operations; the latter in cooperation with personnel of the Agricultural Engineering Research Division. Comparative injury data on tangerines handled in pallet boxes and in conventional field boxes were obtained through cooperation of personnel of the Citrus Experiment Station. The entire effort was

directed toward completing and publishing a final report to supersede Marketing Research Report No. 529, "Handling Florida Oranges in Pallet Boxes," which was published as an interim report, April 1962.

In the work on tangerine injuries, two tests were conducted to obtain further information on injuries to tangerines handled in full depth pallet boxes. Results showed no more decay for tangerines in pallet boxes than in conventional field boxes.

Process charts were prepared for the field-box system, pallet-box system, full-bulk system, and a modified full-bulk system. Summaries of these charts were made, providing comparative information on the number of operations, transportations, storages, and delays involved in each system. Approximately 900 feet of 16 mm. color movie film was shot of these systems to produce a motion picture which will show and compare the field-box system and newer systems of handling fresh citrus from the picking area to the packing line.

Data on weights of packed 4/5-bushel cartons of grapefruit were obtained from commercial packinghouses to: (1) Gain information on filled container weight versus dimension sizing from containers as commercially packed; and (2) compare computed container weights involving use of volumes with actual container weights. Each fruit was measured for polar and equatorial diameter using approved calipers. Specific gravity determinations were made of samples of fruit from each carton through cooperation of the Lake Alfred Citrus Experiment Station. Measurements of the fruit in each carton were averaged and volume determined by means of tables. Using the volume and the specific gravity values, theoretical carton weights were computed and compared with the actual weights.

The actual packed carton weights were all less than the computed carton weights in amounts ranging from two to eight percent. These preliminary data indicate some of the problems involved in the possible use of weight-fill in lieu of count-fill of shipping containers; including the effect of variability in specific gravity and fruit shape.

B. Handling and Packing Deciduous Fruits

This research is directed toward the development of more efficient work methods and equipment for handling, washing, sorting, sizing and packing apples. It includes a study of the impact of electronic color sorting of apples on related packinghouse operations and an evaluation of presizing and presorting apples in commercial storages and packinghouses.

1. At Wenatchee, Wash., research was directed toward determining costs of the electronic color sorting of apples, observing the action of the fruit as it passed through the machine to make determinations of the bruising incurred by fruit from the color sorter, measuring operating capacities for 6- and 4-row scanners, and making preliminary observations of manual sorting operations of apples presorted for color.

Although the sorter does an excellent job of separating both red and yellow varieties of fruit by degrees of surface color, the high cost of the unit is prohibitive for any but the largest packinghouses. Moreover, apples, as currently handled by the electronic color sorter, are subject to additional bruising. Although it was found that the color sorter does result in a higher percentage of Extra-Fancy grade apples in any given lot being delivered from the sorting table to the packers, the number of sorters still necessary to inspect for surface defects leaves some doubt as to the economy of electronically presorting for color.

Research was conducted on determining the requirements for a unitized brush-sizer and preparing the designs for a prototype unit. The unitized brush-sizer is an entirely new concept of a fruit sorting and sizing line in which a single equipment item; instead of three separate units; is used to sort, size, and brush fruit. Design drawings were completed, specifications written, and bids obtained from equipment manufacturers for the construction and installation of this item of equipment in a commercial apple packing-house for test purposes. A contract to construct and install the prototype brush-sizer has been let to a Wenatchee, Wash. firm and the unit should be ready for tests early in 1965.

During the design phase, a mock-up of the sizing section of the unitized line was built and the effectiveness of this method of dimension sizing was tested. These tests showed that sizing apples by this method was fully as effective as when conventional sizers are used, and the brush-sizer showed promise of even greater effectiveness. During the tests, some apple specimens were "run" on the sizer as many as 10 times with no indication of damage to any of the fruit. Peaches, apricots, pears, and plums were also sized on the unitized brush-sizer mock-up. The preliminary findings of these tests indicate that these fruit varieties can be sized satisfactorily, and, after properly adjusting the rotational rates of the brushes, damage to the fruit is nominal.

Work sampling studies of a re-sorting operation of fruit that had been sorted prior to storage indicate that sorters react to once-sorted fruit much the same as they do fruit which is being sorted for the first time; that is, they feel it is necessary to remove fruit at a fairly consistent rate from the sorting table regardless of the incoming fruit quality.

2. At East Lansing, Mich., under a cooperative agreement with the State Station, research was continued on the design of equipment which uses water as a medium for dumping, sorting, sizing and filling apples back into pallet boxes. During the report period special attention was given to a hydro-filling device and to evaluating bruising and sizing accuracy and efficiency for various speeds of the recommended submerged chain sizer. McIntosh, Red Delicious, Jonathan, and Golden Delicious apples were used in these tests. A final report, "Development of a Hydro-Handling System for Sorting and Sizing Apples for Storage in Bulk Boxes," was submitted by the Station in

connection with the cooperative agreement, for publication by the Department. This report should serve as a guide for equipment manufacturers, storage and packinghouse operators, and researchers in the further development of hydro-handling systems for apples.

3. At Athens, Ga., research was initiated on handling and packing peaches in commercial facilities. Following a search of the literature on handling peaches, approximately 30 peach packinghouses in Georgia, South Carolina, and Florida and one equipment manufacturer in Georgia, were visited to inspect the equipment and facilities presently in use and to establish industry contacts needed for conducting field studies. Indications are that many existing facilities are not being efficiently utilized, but that a number of new facilities are being built or planned, and many existing packinghouses are being remodeled. In many cases, equipment replacement also is contemplated; all of which indicates the immediate need for research to provide guidelines for layouts for peach packinghouses and improved equipment.

Engineering studies were conducted in 15 peach packinghouses in Georgia and South Carolina. Data were obtained on facilities, equipment requirements and capacities, floor space requirements, layouts, work methods including crew sizes, and operating procedures. Based on these findings, the development of improved layouts for synthesized packing operations of selected sizes was started. The layouts will provide packinghouse operators with guidelines for making needed improvements.

Three methods of receiving and two methods of dumping peaches from field containers were studied. Time study and micromotion data were obtained on the following three methods of moving one bushel field crates of peaches from a truck to a temporary storage area: (1) Conveyor, (2) 2-wheel hand clamp truck, and (3) pallet and forklift truck. The two methods of dumping studied were manual and mechanical. These data have not been analyzed.

4. In the Hyattsville, Md. office, the first draft of the manuscript "Apple Packing Methods and Equipment," based on contract research completed several years ago, was completed and will be submitted to the Wenatchee, Wash. field office for up-dating. This report when completed will contain a description and analysis of methods and equipment for preparing apples for market; not including the sorting operation.

C. Handling and Packing Potatoes

1. Presque Isle, Me. Research under this project, which is cooperative with the Maine Station, is directed toward reducing operating costs of potato storages and packinghouses by increasing the productivity of labor employed and reducing losses from bruises and mechanical injuries in handling, storing, cleaning, grading, sizing and packing potatoes. It involves the development of more efficient work methods, operating procedures, equipment, and facilities for handling, storing, and preparing for market Maine potatoes.

Experiments on bruise resistance of potatoes, as related to changes in temperature of the surrounding air, were continued. Measurement was made of the amount of bruise injury inflicted by dropping a 0.6 pound weight on individual potatoes from heights of 18, 12, or 9 inches. Tests were made with the potatoes at the storage temperature of 45° F. and after samples were held in 60° F. air for intervals of 1, 2, 3, and 4 hours after removal from storage. The average resistance to bruising had an increasing trend through the warming period with most of the increase occurring in the first two hours. After four hours, the results approximated those of tests on potatoes stored at the 60° F. temperature. Impact from 3 drops of the weight from a height of 12 inches inflicted about one-third as much injury as was produced by two drops from a height of 18 inches. Bruising produced by the impact of four 9-inch drops was almost negligible. Tests made by dropping the weight from progressively increased height until visible bruising occurred, with time and temperature conditions similar to those used in the repeated impact experiment, show generally corroborative results. Results of these tests should provide guides for manufacturers of handling, grading, and packing equipment for producing equipment which will minimize bruising of potatoes.

Additional work was done on a manuscript, "Evaluation of a Bulk Railroad Car for Potatoes," and work was initiated on a manuscript, "Supplying the Packing Line with Potatoes in Maine Storages at Rates Above 200 Hundredweight per Hour."

2. Gainesville, Fla. This program, carried out in cooperation with the Florida Station, has as its objective the development of more efficient work methods, operating procedures, and equipment for the handling and preparation for market of potatoes in spring crop areas.

A draft of a manuscript was prepared based on the results of research conducted in the Hastings-Elkton area to develop improved systems for handling potatoes in bulk from the harvesting operation to the packing line. Drawings and other information from which potato growers and shippers can install a bulk-dumping system, as developed through the research, were included. Preliminary cost estimates for the different systems included in the research showed the bulk-dumping system to be 16 percent lower in cost than the conventional system (hopper-body trucks and sloping-bottom bins) and 19 percent less than for the pallet-box system (boxes filled on truck from harvester).

Two bulk-handling systems were studied in the Homestead area where a commercial installation of each system recently has been made. In a pallet-box system, potatoes are transferred to the boxes after being hauled to the packinghouse in hopper-body trucks. In a drive-in bin system, bin loader equipment is used for receiving potatoes from hopper-body trucks. Information on injury was obtained for each of the two new systems and for a conventional system (digger-field box), following a 6 x 6 latin square statistical design. Data on labor and equipment time requirements for the new systems were obtained through time studies. Tuber injury studies show: (1) There was no

significant difference between the conventional single- or two-row digger used in the conventional system and the mechanical harvester used in the new (bulk) systems; (2) there was no significant difference between receiving in field boxes or receiving in hopper-body trucks directly to the line; and (3) there was no significant difference in holding the potatoes in drive-in bins or in using pallet boxes for holding.

3. Red River Valley Potato Research Center, East Grand Forks, Minn. Work is directed toward developing more efficient work methods, techniques, devices, and equipment for the handling and preparation for market mid-western fall-crop potatoes.

Handling.--A vertical-telescoping, deep-bin filler designed by the Agricultural Engineering Department, University of Minnesota, was tested to evaluate design principles, capacity, and tuber damage. General design seemed quite feasible, but several modifications were found to be needed to reduce tuber injury occurring on the horizontal feeder belt. The vertical conveying section of the machine performed quite satisfactorily.

A scaled down version of the "Spudnik" designed to operate in bulk rail cars was moved from Moscow, Idaho, to the Center but was used only for limited tests because of the serious traction problems which would require extensive modifications of the unit.

Tuber injury evaluations for each machine were made by the Market Quality Research Division.

Cleaning and Sizing Before Storage.--Norland and Pontiac variety potatoes again were sized into storage with the following size classifications: "B" size, less than 2 inches; "A" size, 2 to 3½ inches; "Jumbo" size, over 3½ inches. An expanding-pitch, spool sizer was used. A check bin was filled with field-run potatoes in order to evaluate any effects sizing might have on air movement by comparing temperatures in this bin to temperatures in an identical bin of sized potatoes. Thermocouples and sample bags were placed throughout all bins to measure temperatures and weight loss, volume change and shrinkage respectively.

Generally, for the field-run potatoes over 90 percent were in the "A" size, and less than 5 percent in the "B" and "Jumbo" classes. Samples taken from the "A" section of the sizer contained 92 percent "A's," 5 percent "B's," and 3 percent "Jumbos." Because of the predominance of A-size potatoes in field-run lots, sizing made but little improvement in the field-run lots. Also, because of this small change in the percentages of "A's," bin temperature variations could not be attributed to sizing. Better accuracy in sizing might have been obtained if a more uniform feeding rate could have been maintained.

Weight loss of stored potatoes averaged 4½ percent for 19 samples, and varied from 3½ to 6½ percent. This is consistent with past results for table stock potatoes stored at 32° to 40° F.

Shrinkage or dimensional changes averaged $2\frac{1}{2}$ percent and ranged from 1.0 percent to $3\frac{1}{2}$ percent. Generally tubers appeared to shrink an equal amount on each measured axis.

Market Quality Research Division evaluations of the damage done by sizing showed damage to the "A" size tubers was minor, but that "Jumbo" size tubers were more extensively damaged by the sizer.

D. Handling and Packing Vegetables

At Gainesville, Fla., this research has as its objective the development of improved work methods, equipment, devices and operational procedures for the handling and preparation for market of vegetables at shipping points.

A manuscript on packing mature-green tomatoes at Florida shipping points, which was completed during the year, covers container assembly, filling containers, checkweighing and closing filled containers, handling stacks of filled containers with two-wheel clamp-type handtrucks, and loading for shipment. Changes in equipment and layout of the packing stations are described in the report to show how packinghouses handling the equivalent of 200,000 sixty-pound containers can save up to \$7,000 annually in equipment and labor costs. This report should be released and distributed during the last quarter of 1964.

Labor costs were estimated for the present complete operation of cutting, sizing, and packing celery into crates and of handling packed crates from the field to the precooling plant, and moving them through the hydrocooler and into a railroad car or semi-trailer truck for shipping. Flow process charts, system descriptions, and estimated labor requirements were prepared for improved handling systems which offered potential cost savings as compared to the present system. The reduction in crew size is sufficient with the best proposed system to realize an estimated labor savings of 7.8 cents per crate from present labor costs of 22.6 cents per crate (or 35 percent) for celery cutting, sizing, packing, precooling, and loading crates for shipment.

An alternate system of handling, which was developed for growers who wish to retain celery packing in the field, utilizes the mule-train field packing unit as presently used in celery harvesting. A trailer equipped with 5 loading platforms is towed behind the mule-train. Crates of each size of celery are stacked on separate loading platforms. Completed pallet loads are lowered to the ground by hydraulic actuated platforms. A field truck with a hydraulic hoist and a pallet pickup attachment picks up the pallet loads and transports them to a central precooling plant. At the plant, forktrucks unload palletized stacks of crates from the truck and deposit them in the hydrocooler. Forktrucks are also used to transport precooled stacks of crates to a railroad car or semi-trailer truck for shipment. Estimated savings of labor and equipment costs for this system of handling are two cents per crate as compared to the present system of harvesting, sizing, packing, precooling, and loading for shipment.

A field truck with hoist, which would be used in the latter system of handling, was tested to determine its feasibility in a muck celery field. The equipment performed satisfactorily with the exception of a minor center of gravity design problem which was corrected later. Some care is also necessary on the part of the operator to prevent the vehicle turning over on the soft muck field when the load weighing 2,000 lbs. is picked up at right angles to the bed of the truck.

Handling tests were also conducted to determine feasibility of handling celery in bulk from field to central packing facility. In the tests, celery stalks were cut in the field, dropped into 47- by 47- by 30-inch pallet boxes, transported 2 miles, and evaluated for scuffing, bruising, and petiole breakage injuries. The tests were designed to compare effects of jumbled and oriented stalk arrangement in the bulk container and degree of petiole stripping completed in the field prior to placing stalks into the bulk container. Results of the experiment indicate that significantly less injury was received by non-stripped stalks handled in jumbled arrangement in pallet boxes than was received by stalks that were handled after being completely stripped in the field. There was no significant difference in injury between stalks handled in oriented and jumbled arrangement in the bulk container except when handling completely stripped stalks. Non-stripped stalks which were handled in jumbled arrangement in pallet boxes had major scoreable injury on 0.24 percent of the stalks, minor scoreable injury on 0.48 percent of the stalks and minor bruising injury on 3.34 percent of the stalks.

E. Storage of Deciduous Fruit

1. Cooling Rates. The purposes of this research, at Wenatchee, Wash., are to: (1) Measure and evaluate the cooling rates of fruits in storage and shipping containers in terms of container designs that properly protect the fruit, shorten the cooling period, and maintain the fruit at proper storage temperatures; and (2) develop improved handling, stacking, and storage practices.

Work was undertaken to improve the use of matched thermistors for measuring very low velocity (0 to 15 feet per minute) airflow to overcome difficulties encountered by this method in studies of cooling rates.

To provide needed variables for cooling rate studies to be made during the 1964-65 season, 12 fiberboard apple containers, six glued and six stapled, were obtained. Enlarged holes and extra holes, located to conserve the strength of the box and to provide the best possible ventilation, were placed in the ends of all but two of these boxes. Five different hole patterns were placed in the ends of each of two types of containers. Of these 10 containers, two special holes were located in each end, an oblong slot $1\frac{1}{2}$ inches down from the top of the box 4 inches long by 1 inch wide with rounded ends and centrally located, and three additional holes 2 inches in diameter. One of these located centrally in the end and one in each lower corner $3\frac{1}{2}$ inches

in from the sides and $1\frac{1}{2}$ inches up from the bottom. Compression tests were then made to see what effect the holes had on the strength of the boxes. There was very little effect on the box strength by the holes and the stapled boxes were slightly stronger than the glued ones.

A cooling study run on a new type of telescoping fiberboard container or lug for cherries showed that the cooling rate of the cherries packed in the lugs was not fast enough to allow the packing of warm cherries direct from the field and then expect to cool them sufficiently overnight for shipment.

2. Refrigerated Storage. The objectives of this project at Wenatchee, Wash. are to: (1) Investigate airflow and distribution methods, patterns, and rates in refrigerated fruit storages to determine and evaluate the influence of these factors on cooling fruit and on bringing it to optimum storage temperatures; (2) determine and evaluate heat gains through various structural features of fruit storages and make suggestions for improved designs; (3) redesign storage houses for the most efficient handling and storage of fruit in pallet boxes; and (4) evaluate hydrocooling of apples before placing in storage.

Studies of air doors installed in storages in the Wenatchee, Wash., area, made in cooperation with personnel of the Environmental Control Division, U. S. Naval Civil Engineering Laboratory, covered air door construction, airflow patterns, and operation. Operators of cold storages having air doors agreed as to the efficiencies gained by the removal of conventional doors under the present system of handling fruit in and out of the storages with industrial lift trucks.

A study of air temperatures and air distribution in one storage stacked full of pallet boxes of apples including the aisles showed a temperature variation of 5.2° F. throughout the room. Previous studies of this same storage with normal load and the aisles free of pallet boxes showed a temperature variation of only 2.7° F., which indicates how overcrowding can disrupt the airflow patterns.

In a study at another storage, thermocouples placed in the center of an apple in a packed box of apples at six locations throughout the room showed from readings at the two-week storage period that the temperature of the fruit at two locations was 37° F. A check of the airflow pattern showed that the air was being improperly distributed. Plywood baffles were placed at several locations to direct the air into the warm area and within one week the core temperature of the fruit had dropped to 32° F.

A new method of applying 4 inches of styrofoam insulation to tiltup concrete walls was developed and tried on a recently constructed storage. The styrofoam panels were laid out on the previously constructed concrete floor, then the concrete wall poured on top of them. When the concrete had set, the wall section was lifted into place in a vertical position with the insulation

adhering to the concrete wall section. The striking feature of this method of construction is that no adhesive is used between the insulation and the concrete wall section. A natural bond occurs between the poured concrete and the styrofoam insulation. This method saves much labor in applying the insulation and is much easier and cheaper. As this method does not use a vapor barrier, some trouble with moisture infiltrating the insulation may occur.

After studying in detail USDA Circular No. 740, "Cold Storage of Apples and Pears," with the idea of updating it, it was decided in light of new developments and practices to prepare a new report on cold storage operation.

As a service to Washington State University Extension Service, personnel collaboration was given in the preparation of the bulletin E.M. 2344, "Instruments for Measuring Cold Storage Temperatures and Humidity," published by Washington State University.

Collaboration also was given in conducting a storage clinic which was attended by 45 storage operators and managers. Instruments for measuring humidity, temperature, and air movement were displayed and discussed. A 26-page paper was presented covering: (a) Refrigeration equipment and its operating characteristics; (b) cooling capacity; (c) relationship of cooling rate to humidity control; (d) air volume and air circulation; (e) need for rapid cooling--removal of field heat; (f) fruit temperature in relation to storage life; (g) humidity control and atmospheric condition that effects apple quality in storage; and (h) rates of cooling as effected by containers and stacking methods. Other research personnel cooperating with the clinic discussed: (a) Segregating harvest maturity; and (b) harvest maturity for long storage.

To improve storage management, a special effort was undertaken in 1961 with one storage operator by installing thermocouples in his storage room to show temperatures throughout the room. Humidity conditions were improved by constant checking. The results from the 30,000 packed boxes of apples stored in the room the first season were so encouraging that other operators have applied the same principles. By 1963 there were roughly 400,000 boxes of apples held in special storages similarly equipped and managed. Over 750,000 boxes of "special storage" apples are planned for the 1964 season and five additional houses are studying their facilities in anticipation of converting to special storage.

Experience to date indicates that "special storage" involves three factors: (1) Apples must be picked at optimum maturity; (2) once picked the fruit must be cooled quickly and stored at 30° to 31° F.; and (3) humidity must be kept high (above 85%).

3. Controlled Atmosphere Storage of Apples. Work on this project is designed to develop improved methods, techniques, equipment, and facilities for the controlled atmosphere (C.A.) storage of apples in the Pacific Northwest, and is in cooperation with the Market Quality Research Division.

In a test made to determine if there would be any significant difference in the cooling rates, four thermocouples were placed in each of two C.A. storage rooms, one using the Tectrol (Whirlpool Corp.) system of C.A. and the other conventional C.A. using a caustic scrubber to remove excess CO₂ from the storage room air. Even though Tectrol C.A. continually blows warm air into the room, temperature curves indicated that the two rooms cooled at the same rate and held their temperatures well, which was an indication of ample refrigeration in each room. Humidifiers were placed in each room to keep the relative humidity above 95 percent. Some difficulty was experienced when the rooms were opened in May. Excess moisture had run down through the stacks of boxes of packed fruit and frozen making it necessary to chip away the ice before the stacks of fruit could be removed. As a result it was necessary to replace the outer covering or telescoping lids on many boxes. The study of these two C.A. rooms indicates that there is no distinguishable difference in the fruit when removed from the rooms if the temperatures and humidity are held relatively the same.

F. Storage of Potatoes

Work under this program, at the Red River Valley Potato Research Center, is directed toward providing optimum storage conditions for fall-crop potatoes for table stock, seed, and processing; and developing improved layouts and designs for potato storage houses, which will permit the use of the most efficient handling and packing methods and keeping injury and mechanical injury to a minimum and minimize construction and maintenance costs.

1. For Table Stock and Seed. Further work was done on rewriting the manuscript, "Fall-Crop Potato Storages." It is intended that this report include recommendations regarding construction techniques, layout and design, air circulation and ventilation systems, insulation, building materials, and other essentials. Preparation of design drawings and specifications for a 60,000 cwt. capacity door per bin storage are about three quarters completed. The initial design was expanded to include shipping room, electrical, and site details. Major portion of time was devoted to structural, ventilation, and electrical design.

Three bin fronts were designed to span the 12-foot bin entrances in the door per bin storage, but have not been tested. A "T" shaped bin front which spans 20 feet was designed and tested. This span is needed to facilitate handling of equipment in wide storage bins.

During the report period, project personnel provided assistance on problems associated with storage construction and regulation, handling, and equipment to over 200 firms and individuals.

2. For Processing. The storage of Irish Cobbler, Pontiac, Kennebec and Snowflake potatoes at 40°, 45°, and 50° F. and subsequent flaking was continued as in the previous year. Samples were flaked from January through July. The 40° and 45° F. samples were reconditioned for 4 weeks at 65° F. Results to date show that storage temperatures did not affect any of the recorded flake variables.

Storage temperature, relative humidity and potato weight loss data have not been completely analyzed. Temperature control in the controlled temperature rooms was more precise this year throughout the whole storage period. Relative humidity control above 80 percent needs to be improved.

The effect of shell ventilation and a combination of shell and through ventilation methods on storage temperature uniformity was evaluated for chip stock storage at an average temperature of 55° F. Actual airflow rates were approximately .35 c.f.m. per hundredweight, which is half the flow used by most commercial operators. This reduced rate was used because of air distribution problems. Temperature data are still being analyzed. All lots of potatoes chipped satisfactorily.

Weight loss at 55° F. average temperature varied from 4 to 9 percent and averaged 6 percent. There was no definite relationship between ventilation methods and weight loss at the airflow rates used.

G. Cooling Deciduous Fruits

This research is designed to develop improved methods, equipment, operating practices, and techniques for use in existing or new facilities for more efficient cooling of deciduous fruits.

At Wenatchee, Wash., work on this project consisted of studying the effect of hydrocooling of apples and the overall operation of a cold storage room during a hot season. The hydrocooler used in the test, was approximately 8-feet wide and 90-feet long. Apples were elevated into the hydrocooler from a submersion type water dumper by elevating rollers, floated the length of the hydrocooler, and then elevated onto brushes and then on through the sorting, sizing and packing line. The length of time the apples were in the hydrocooler varied according to the receiving load but averaged about 16 minutes. During that period the apple temperature was reduced about 16 degrees, or about 1 degree per minute.

The hydrocooler, which handles from 3,000 to 4,000 field boxes of fruit per day, could not handle all the apples as fast as they were received from the orchard during the 1963 tests. The boxes of apples that could not be immediately hydrocooled were placed directly into cold storage to be packed at a later date. Using this method the storage was able to maintain good cooling temperature at all times. Most storages in the area at the same time were having trouble in keeping the temperatures of their rooms low because of the large volume of fruit being received per day and placed into the storages.

One commercial storage house installed a hydrocooler for cooling cherries directly from the field. The cherries were first sorted and sized. The fruit went into the hydrocooler from the sizer. From the hydrocooler the cherries were packed in lugs and moved directly into cold storage. Tests show this type of cooling has the advantage over air cooling in that the stems do not lose moisture during the cooling process and retain their green appearance. The advantage of this method is that all the field heat is quickly removed from the fruit before it is packed and, as a result, should have a longer shelf life.

At Athens, Ga., convective heat transfer coefficients from the surface of Golden Delicious and Jonathan apples to air were measured at approach velocities of 300, 500, 800, and 1,150 feet per minute. Experimental coefficients were compared with theoretical values computed at each of the respective approach velocities. Positive correlation coefficients between theoretical and experimental were 0.971 for the Jonathan and 0.732 for the Golden Delicious. The chief value of these results lies in their verification of close surface temperature measurement. The same procedure applied to a larger scale in bulk fruit enables the prediction of surface heat transfer parameters under conditions in commercial practice.

Tests were conducted to measure the temperature distribution within Golden Delicious apples when a single specimen was subjected to forced-air, in the laboratory wind tunnel, at air temperatures of 10°, 15°, and 20° F., and approach velocities ranging from 285 to 1,155 f.p.m. After 30 minutes of cooling with air at 10° F. approaching a 2.7-inch diameter apple at 490 feet per minute, the average temperature on the fruit surface was 29° F. Its mass-average temperature was reduced from 75° to 36° F. The mass-average temperature of a 2.8-inch diameter Golden Delicious apple was reduced from 75° F. to 42° F. in 30 minutes with air at 15° F. approaching the fruit at 490 feet per minute. These examples illustrate the effectiveness of air as a heat exchange medium in precooling certain products. The results substantiate findings with oranges at Gainesville, Fla., and point toward the possibility of more efficient use of air in commercial precooling operations.

A manuscript, "Hydrocooling Peaches," was prepared as a popular version of Technical Bulletin No. 1292, "Thermal Characteristics of Peaches as Related to Hydrocooling."

Plans and specifications were prepared for the construction of an experimental, portable forced-air precooler for commercial-scale tests at packing-houses, and a contract was let for its construction.

H. Cooling Citrus Fruits

Hydrocooling; the most widely used method for rapidly removing the field or harvest heat of such commodities as peaches, sweet corn, and citrus fruits; presents certain problems--particularly in the case of citrus--where detrimental physiological effects sometimes result. Existing methods of

hydrocooling are also cumbersome and inefficient. Research conducted at Orlando and Gainesville, Fla., is designed to develop improved methods, equipment, operating practices, and techniques for use in existing or new facilities for more efficient precooling of fruits and vegetables.

Precooling studies of oranges in a wind tunnel revealed that considerable variation in surface temperature exists, depending upon location on the fruit with respect to direction of airflow.

Laboratory studies to determine the basic heat transfer characteristics and their relation to moisture content of Hamlin and Valencia oranges and Marsh grapefruit were continued at Orlando. Test results show a correlation between moisture content and thermal conductivity. Results of this work will make possible more efficient designs of precooling systems and eliminate the need for much of the costly "trial and error" type of applied research. A technical paper giving the procedure and findings of some of this work was presented at the Annual Meeting of American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Cleveland, Ohio, June 29, 1964.

The pilot-scale forced-air precooler chamber at Gainesville, was used to continue precooling research on citrus fruit. Using an initial air temperature of 15° F., precooling time of 60 minutes, and volume of airflow ranges of 2,980 to 7,410 c.f.m. in test runs of oranges, 3,180 to 8,040 c.f.m. for grapefruit, and 2,870 to 8,040 c.f.m. for tangelos, some of the findings are as follows: Loss of moisture per test run was 0.6 to 0.8 percent; consequently, evaporative cooling was not an influencing factor. Reduction in temperature during test runs was 35.7° to 49.4° F. for oranges, 33.1° to 47.7° F. for grapefruit, and 34.7° to 54.7° F. for tangelos. Cooling was found to be markedly faster with initial fruit temperatures of 80° to 90° F. than with about 70° F. Cooling coefficients ranged from 2.48° to 5.48° F. per (°F.) and were inversely correlated with fruit size. Surface convective coefficients of heat transfer varied from 7.14 to 15.26 Btu per hr. (sq.ft.) (°F.). Theoretical heat removal ranged from 35.7 to 74.0 Btu per lb. in test runs of oranges, 31.1 to 55.5 Btu per lb. for grapefruit, and 33.9 to 76.4 Btu per lb. for tangelos. Corresponding experimental heat removal was 28.4 to 40.8 Btu per pound for oranges, 24.3 to 40.5 for grapefruit, and 28.9 to 45.7 for tangelos.

For the mass-average temperature data, 36 test runs were made with 500-lb. lots of Hamlin oranges, Marsh and Foster grapefruit, and Orlando tangelos. Fruit was cooled for 1.0 to 1.5 hrs. under a variety of test conditions. Initial air temperature was 15° F. Fruit temperatures were sensed with surface thermocouples and multipoint thermal probes inserted through the stylar end (polar) or the largest radius (equatorial). Temperature data from over 10,000 observations with corresponding time and distance along the radius values were transformed into normalized form for analysis as third-degree-polynomial multiple regression equations. Total correlation coefficients ranged from 0.97411 to 0.99917 among 216 individual equations and from 0.93454 to 0.98160 among equations of grouped data. Average location

of the mass-average point was 0.7856 for oranges, 0.7722 for grapefruit, and 0.7953 for tangelos (where, 0.0 = center of the fruit and 1.0 = surface of the fruit). Approach of internal temperature distribution to apparent linearity was influenced by fruit characteristics, such as size and shape, as well as heat transfer from fruit surfaces or along the probes. A study of temperature distribution showed that a temperature representative of an entire fruit could be obtained only at the mass-average point.

I. Cooling Vegetables

This research at Gainesville, Fla., is designed to develop improved methods, operating practices, and techniques for use in existing and new facilities for more efficient cooling of vegetables. The research is directly related to that on the cooling of celery in unit loads previously reported.

Work on this project was confined to the preparation of the manuscript, "Forced-Air Precooling Spring Crop Potatoes," which was based on data obtained earlier on four precooling test runs on potatoes in 100-pound bags using forced-air as the precooling medium. It was found that potatoes can be precooled with forced air colder than 32° F., without damage, as long as the surface temperature does not go below 28.9° F. Present portable air cooling units require 4 to 6 hours to cool potatoes in a railroad car or trailer truck. Forced-air precooling with air below 32° could reduce the temperature of potatoes from 90° to 60° F. in less than 1 hour and offers the possibility of using this system of precooling in the future.

J. Handling Grapes in Pallet Boxes

This research covers the development of improved work methods and equipment for handling Concord grapes at processing plants, and is cooperative with the Agricultural Engineering Research Division.

An analysis of data for in-plant labor and equipment requirements and costs for handling and transporting Concord grapes in experimental bins having a capacity of 650 pounds and on conventional lugs, revealed that the labor force for receiving 10,000 tons annually could be reduced from 16 to 3 workers, and that the saving in labor cost was considerably greater than the cost of the additional equipment that was necessary with the bulk handling method. These cost relationships were also computed for annual volumes of 20,000 and 5,000 tons with comparable savings at these volumes to grape processors through the use of bulk containers.

A section relating to methods and costs of handling grapes in processing plants by both the conventional and experimental methods was prepared for inclusion in a final report to be prepared by Agricultural Engineering Research Division, and completes the research in this area.

K. Handling Vegetables in Pallet Boxes

1. Tomatoes. Recent developments in the production and harvesting of tomatoes, such as mechanical harvesting for processing, has brought about an urgent need for the development of larger containers than field boxes for handling this commodity. Because of this need, research on handling and ripening tomatoes in pallet boxes has been undertaken at East Lansing, Mich., under a cooperative agreement with the Michigan Agricultural Experiment Station.

The pallet boxes designed and constructed during the previous report period were used initially for handling mechanically harvested tomatoes in order to evaluate the various types of pallet boxes and the injury they cause to tomatoes. Hand harvested tomatoes were used as a check lot.

Arrangements made to ship mature-green and pink tomatoes from Homestead, Fla. to East Lansing, Mich. for the purpose of evaluating the use of several pallet boxes for the handling and shipment of tomatoes over long distances, were abandoned due to a very severe frost in the Homestead area. Arrangements were then made with a shipper near Montecello, Ark. to complete these tests. Tomatoes were packed into baskets and either dumped or placed by hand into pallet boxes. Nine 25-pound crates, which are commonly used in Arkansas, were filled and accompanied the shipment of pallet boxes. The containers were loaded onto a 2½-ton truck and hauled directly from Arkansas to East Lansing, Mich., a distance of 975 miles.

The comparison in bruising of tomatoes shipped in 25-pound crates and in 670-pound pallet boxes indicates that pallet boxes offer an excellent shipping medium for green tomatoes. By wrapping and packing the tomatoes in pallet boxes, the bruising will not be higher than when 25-pound crates are used. Dumping the tomatoes in a pallet box results in an increased percentage of bruising as compared to dumping the tomatoes in 25-pound crates. The wood pallet box performed better than did the plastic or mesh-wire pallet boxes. The cooperator's final report on this project contains the detailed results of this research and will serve as a manuscript for a Department publication.

2. Sweetpotatoes. This research is designed to increase the efficiency and reduce the unit cost of handling, curing, storing, and preparation for market of sweetpotatoes and to minimize losses from spoilage and deterioration. This work is being conducted at Raleigh, N. C., under a cooperative agreement with the North Carolina Agricultural Experiment Station and the North Carolina State Department of Agriculture.

Handling and curing tests were continued with palletized loads of two types of wirebound field crates at two storage houses. Bushel baskets handled in the usual way were used as check lots or control.

Weight loss during the two month period of curing and storage for the crate was about 35 percent less than in the bushel baskets. Defects which were

severe enough to drop the grade level amounted to 4.1 percent of original weight for crates and 9.1 for baskets. Non-grade defects which effect appearance but not grade were about 25 percent less for the crates. In total, out of a 100 pound lot of sweetpotatoes about 89 pounds were marketable when handled in crates and about 80 pounds when handled in bushel baskets.

The preliminary report on, "Pallet Boxes and Palletized Containers for Handling and Storing Sweetpotatoes" was revised to include results of the second year's work.

L. Handling and Packing Fruits and Vegetables on Terminal Markets

1. Tiering Devices and Equipment. This research by the Hyattsville office was directed toward reducing the cost of storing fruits and vegetables at the wholesale level by increasing the utilization of available storage space in wholesale fruit and vegetable warehouses. During the report year work in this area was confined to the editing and publication of Marketing Research Report No. 622, "Storing Fruits and Vegetables on Pallets in Wholesale Warehouses."

2. Loading Out Delivery Trucks. The purpose of this research was to evaluate and compare the relative efficiency of selected methods and types of materials handling equipment for order assembly and truckloading used by wholesale distributors of fresh fruits and vegetables supplying both affiliated and non-affiliated retail stores so as to reduce unit costs and minimize spoilage and waste. The research was cooperative with the Wholesaling and Retailing Research Branch. During the report period work in this area was confined to the editing and publication of Marketing Research Report No. 665, "Three Methods for Loading Out Produce in Warehouses."

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Handling and Packing Potatoes

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Storage of Deciduous Fruit

Herrick, Joseph F., Sainsbury, G. F., Carlsen, Earl W., and Hunter, D. Loyd. 1964. Apple Packing and Storage Houses--Layout and Design. Marketing Research Report No. 602, January 1964, 42 pp.

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Yaeger, Earl C. 1963. A Lighter Door Eases Strain for Potato Warehousemen. Agricultural Marketing, Vol. 8, No. 11, November 1963, p. 13.

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Handling and Packing Fruits and Vegetables on Terminal Markets

Ferris, Richard T. 1964. Storing Fruits and Vegetables on Pallets in Wholesale Warehouses. Marketing Research Report No. 622, February 1964, 38 pp.

Lundquist, Arnold L. and Bouma, John C. 1964. Three Methods for Loading Out Produce in Warehouses. Marketing Research Report No. 665, June 1964, 44 pp.

Lundquist, Arnold L. 1964. Is Your Loading Out Method Efficient? Agricultural Marketing, Vol. 9, No. 7, July 1964, pp. 4 and 5.

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AREA 5

LIVESTOCK, MEAT, AND WOOL - MARKETING FACILITIES EQUIPMENT, AND METHODS

Problem. Many of the livestock, meat, and wool marketing, slaughter, and warehouse facilities occupied today are obsolete and the work methods that can be used in such facilities are antiquated. As a consequence, labor costs are excessive and they are increasing. Many firms still are occupying facilities designed primarily for handling rail receipts and rail shipments even though the majority of these products today are moved by motor-truck. This situation also adds to handling costs. Numerous firms are occupying "makeshift" facilities which were designed for other uses or for work methods and operations of a bygone era when labor costs were low. Changes in transportation systems, population growths and shifts, and advancements in technology also have brought about changes in the types of facilities--such as livestock auction markets, commercial feedlots, and hotel supply houses. Most private firms handling livestock, meat, and wool lack the technological and engineering skills necessary to plan and develop suitable facility layouts and designs and to select the types of equipment needed. Therefore, engineering and related research is needed to provide guidelines for industry to increase efficiency; including the designing of improved plant layouts, which will provide proper arrangement of work areas to minimize travel distances and excessive handling and the development of work methods that will permit use of mechanized and automated equipment rather than the relatively high-cost manual methods now used in many plants.

USDA AND COOPERATIVE PROGRAM

The Department has a continuing long-term marketing research program involving industrial engineers, agricultural economists, and meat scientists engaged in both basic and applied research to develop new and improved methods, equipment, processes, and facilities for livestock markets, meat-packers and wholesalers, and wool warehousemen. Livestock market research is carried on at Hyattsville, Maryland. Part of the work in this area is being done in cooperation with the Missouri Agricultural Experiment Station, Columbia, Mo., and the Central Missouri Livestock Auction, Mexico, Mo. Work on the development of a mechanical driving device and penning system for livestock markets is under a contract with the American Research and Manufacturing Corporation, Rockville, Md. The research on livestock slaughtering and on meatpacking and wholesaling at Stillwater, Okla., is cooperative with the Oklahoma Agricultural Experiment Station. Wool warehouse research is carried on at Hyattsville, Md.

The Federal effort devoted to research in this area during the fiscal year 1964 totaled 5.3 professional man-years; 2.1 man-years (including 1.8 man-years of contract work) on livestock marketing, 2.3 man-years on meat facilities, 0.2 man-year on wool warehouses, and 0.7 man-year on program leadership.

PROGRESS - USDA AND COOPERATIVE PROGRAMS

A. Automation of Sales Operations on Livestock Markets

At the Central Missouri Livestock Auction, Mexico, Mo., the combination electronic load-cell and lever-system scale, and the scoreboard for flashing total weight, average weight, and price to the audience continues to perform well. The manual-key input device for transmitting sales data from the auctioneer's box to the office and the computer for processing this information could not operate at the speed of the fastest sales transaction. During the year the Toledo Scale Corporation, which provided this equipment, abrogated the Memorandum of Understanding covering this part of the work.

The contractor's report from the Toledo Scale Corporation on the physical and economic feasibility of electrically-operated gates was favorable and provided information on gate structure, latching designs, drive systems, and remote controls. A cooperative agreement was negotiated with the Missouri Agricultural Experiment Station for constructing and testing of prototype electrically-operated pen gates. Working drawings, based on data in the contractor's report, were provided the cooperator. Construction of the prototype gates was underway at the end of the report year and laboratory tests and modifications will continue for several months. Tests of the gates under actual operating conditions will be conducted on the Central Missouri Livestock Auction, Mexico, Mo.

B. Determining Behavioral Patterns of Livestock

Under a contract with the American Research and Manufacturing Corporation, Rockville, Md., research to establish behavioral patterns of cattle, hogs, and sheep under environmental conditions existing on stockyards and auction markets was conducted on a site leased from the Baltimore Union Stockyards, Baltimore, Md. The research involved determining the reaction of each species of livestock to (1) light rays of different candlepower, intensity, and bands of the spectrum, (2) sound of different pitch and intensity, (3) air blasts of different velocities and temperatures, (4) electricity applied at different voltages and by various means, (5) a moving "sweep" or "driver" of alley width equipped with selected devices, including rubber fingers, for prodding animals, and (6) selected combinations of the media listed above. The purpose of this research was to determine the feasibility of driving and penning livestock automatically.

The results of the experiments showed that a mechanical sweep with electrically charged bars was the most feasible device or stimuli for driving and penning livestock. No favorable reaction was obtained from the experiments with light rays. These included mercury vapor lamps, flashing xenon lamps, colored lights (red, blue, green, and yellow); and infrared-heat lamps. Reaction to the experiments with sound ranged from moderate to good. White noise produced the least favorable reaction, sinusoidal sound was better, and the amplified human voice was the best of the sound stimuli. Sound was eliminated from consideration as a possible driving device because of the possible effects on other livestock in the market other than those being driven and its irritation and possible painful effect to humans in the market area. Air blasts were considered a relatively good driving stimulus but were less effective than the mechanical sweep with electrically charged bars. The results of the experiments with the mechanical sweep with electrically charged bars were considered sufficiently favorable to proceed with construction and testing of a prototype driving device.

C. Developing an Automatic Driving and Penning System for Livestock Markets

A contract was negotiated with the American Research and Manufacturing Corporation, Rockville, Md., to design, construct, and test a mechanical driving and penning device for livestock markets based on the results of the research on animal behavioral patterns. At the end of the report year the contractor had submitted design drawings of the device in accordance with the requirements of the contract and was proceeding with construction of the prototype.

D. Developing a Physically Integrated Livestock Marketing and Slaughtering Facility

Due to lack of personnel, no work has been done on this project. Research in this area would draw heavily on the results of previously completed livestock marketing and slaughtering work and would require personnel who had either participated in this work or had gained from other sources a broad and comprehensive working knowledge of the engineering and technical skills needed to carry on this work. Personnel qualified to work on this project have been lost due to transfer or reassignment and it has not been possible to employ suitable replacement personnel to do the work. In view of these circumstances, the project has been discontinued until such time as qualified personnel are available to carry out the work.

E. Layouts and Work Methods for Wool Warehouses

At Hyattsville, Md., a manuscript entitled "Layouts and Work Methods for Wool Warehouses" was completed and submitted for publication. The significant results of this research were covered last year.

F. Layouts and Work Methods for Hotel Supply Houses

At Stillwater, Okla., a draft of a report entitled "Hotel and Restaurant Meat Purveyors--Custom Service Houses--Improved Methods and Facilities" was revised to include suggestions made by industry representatives to make the report of more value to and more easily understood by the operators of hotel supply houses. At the end of the year, the report was in Branch clearance.

A draft of a second manuscript covering frozen portion control hotel supply houses was almost complete at the end of the year. This report covers receiving and storing fresh and frozen primal and boneless cuts of meat, fabricating and packaging steaks and chops, preparing ground meat and forming meat patties, freezing packaged products, casing and storing frozen products, and loading out cased products. The report compares the relative efficiency of the various work methods, and equipment types used in performing inplant operations. Use of the lowest cost methods in a plant handling an average of 75,000 pounds of meat and meat products weekly would reduce labor and equipment costs about \$15,500 or 17 percent. Most of the savings are in the labor costs and are due to the use of mechanized equipment such as conveyors, dump-buckets, patty machine feeders, and forklift trucks. An efficient layout was developed based on the lowest cost methods and equipment for this size plant.

G. Layouts and Work Methods for Cattle Slaughtering Plants

At Stillwater, Okla., a manuscript entitled "Cattle Killing Floor Systems and Layouts" was completed and published. The significant results of this study were covered last year.

H. Layouts and Work Methods for Hog Slaughtering Plants

At Stillwater, Okla., in cooperation with the Oklahoma Agricultural Experiment Station, field studies were completed in hog slaughtering plants in 10 central and southern States. The research covered plants slaughtering from 75 to 125 hogs per hour. Most of the plants studied were operating at about 3 to 3.5 hogs per man-hour, substantially less than the goal of 5 hogs per man-hour for small to medium size hog slaughtering plants. The relatively low slaughtering rate found in most plants was due to inefficiencies in the following operations: Driving, stunning, shackling and bleeding, and scalding and shaving. Proper control of scalding temperatures and maintenance of the dehairing machine are the items that would do most to improve efficiency of the slaughtering line. Layouts showing the arrangement of equipment and work areas for an efficient flow of carcasses through the plant have been prepared. A draft of a manuscript covering the results of this research is underway.

I. Handling and Processing "Hot" Pork Products

At Stillwater, Okla., a cooperative project with the Oklahoma Agricultural Experiment Station to study the feasibility of fabricating, curing, smoking, boning, and chilling pork cuts from the "hot" carcass continues. The first 20 pork carcasses were processed and the data obtained were analyzed. The analysis shows that:

1. Yield data are about the same for "hot" and "cold" processed sides.
2. There are no significant differences in flavor, juiciness or tenderness between the hot and cold processed sides.
3. Cutting and boning of the hot side is easier and faster than for the cold side. The information obtained from the first 20 pigs slaughtered is very encouraging.

The second group consisting of 40 pigs were slaughtered in late August and early September. The analysis of the data collected from this group is underway.

PUBLICATIONS - USDA AND COOPERATIVE PROGRAMS

Layouts and Work Methods for Cattle Slaughtering Plants

Hammons, Donald R. 1964. Cattle Killing Floor Systems and Layouts. Marketing Research Report No. 657. 50 pp.

AREA 6

POULTRY AND EGGS - MARKETING FACILITIES EQUIPMENT AND METHODS

Problem. A continuing increase in the production of poultry and eggs in the United States and, in recent years, a marked increase in total consumption of poultry has resulted in significant changes in marketing methods and requirements for these products. These changes have had an impact on poultry processing and egg grading and packing plant facilities and equipment requirements, as well as in operating methods. Problems in this connection generally have been worked out by industry on an individual plant basis. In the main, the answers have furnished only a temporary solution to expansion needs and have been of little help in developing guidelines for new plants or solving general plant production problems and problems involving new processes. In order to improve operating efficiency in existing facilities, and provide guidelines for plant expansion or for new facilities; more efficient work methods, plant layouts, devices, and equipment, and improved facility designs are needed for commercial handling, processing, grading, and packing of poultry and eggs. Such improvements would increase labor productivity, reduce nonlabor inputs, and improve yield without lowering product quality.

USDA AND COOPERATIVE PROGRAM

The Department has a continuing long-term program involving engineers and marketing research analysts engaged in both basic and applied research to develop more efficient work methods, techniques, operating procedures, devices, and equipment and to design improved facilities for the handling and preparing of poultry, eggs, and egg products for market. Research on chicken-class poultry processing operations is carried on in commercial poultry processing plants in the Southeast by Department personnel at Athens, Ga., in cooperation with the Georgia Agricultural Experiment Stations. Contract research on shell egg cleaning techniques and equipment conducted by the University of California at Davis, Calif., was completed during the report year. Contract research to determine the optimum production rates in chicken processing plants for the evisceration and federal post-mortem inspection operations was initiated during the report year and is being conducted by the American Scientific Corporation at Alexandria, Virginia, and in selected poultry processing plants on the Delmarva Peninsula. Research on turkey-class poultry processing, egg products processing, and cleaning, grading, and packing shell eggs is carried on in West Coast turkey processing and in egg grading and packing plants, in cooperation with the California Agricultural Experiment Stations at Davis, Calif.

The Federal effort devoted to research and development work in this area during the fiscal year 1964 totaled 7.0 professional man-years; 3.6 man-years (including 0.6 man-year of contract work) on poultry, 2.3 man-years (including 0.6 man-year of contract work) on shell eggs and egg products, and 1.1 man-year on program leadership.

PROGRESS -- USDA AND COOPERATIVE PROGRAMS

A. Methods, Equipment, and Facilities for Grading and Packing Eggs.

This research concluded in Hyattsville during the report year was directed toward reducing egg marketing costs through engineering and marketing research involving a systems analysis of existing work methods, equipment, and facilities for grading and packing eggs, and the development of improvements. A report of the results of this study has been compiled in a manuscript, "Evaluation of Mechanized Egg Grading and Packing Equipment" which is being reviewed and edited for publication. It will provide guidelines for egg grading plant operators in selecting the degree and combinations of mechanized egg grading and packing equipment that will yield the greatest output per worker and equipment dollar at specified production and product quality levels.

B. Improved Designs for Wholesale Poultry and Egg Distributors' Warehouses

The results of this research, reported last year, were published in MRR 630, "Multiple Occupancy Warehouses for Poultry and Egg Wholesalers, Improved Designs." In addition to furnishing builders and poultry and egg wholesalers with layout, operating, and facility guidelines for multiple-occupancy type warehouses, it is also being used by egg grading and packing plant operators seeking information and assistance for the construction and operation of small egg breaking rooms required for processing undergrade shell eggs.

C. Improved Methods, Techniques and Equipment for Cleaning Eggs

This research conducted at Davis, Calif., involves the development of techniques and equipment that will do an effective in-line job of cleaning shell eggs with minimum quality deterioration and breakage, and that will minimize labor requirements. The basic studies of typical spoilage organisms to determine time and temperature conditions necessary for safe, commercial egg washing, the testing of commercial washers, and the design and the construction and testing of an experimental washer were carried on under contract with the University of California. Preliminary results of this basic work were reported in a technical paper, "How You Can Wash Eggs Cleaner" by A. W. Brant, University of California. A completed manuscript, now being reviewed and edited, reports: (1) The bacteriological, chemical and physical requirements for commercial egg cleaning; and (2) the laboratory test results of the experimental cleaner showing that it removed stain

and dirt from 90 percent of the soiled eggs washed, while commercial equipment cleaned only 21.7 percent, and that it practically eliminated the hazard of spoilage due to washing.

The field tests of the experimental cleaner, conducted by Department personnel, and comparisons of the results with those from commercial cleaners have been completed. Preliminary evaluation of the data indicates that almost the same safe cleaning effectiveness was maintained when the experimental equipment was operated under commercial conditions as that achieved under laboratory conditions. The findings on these tests are now being assembled for publication as a research report.

D. Improved Layouts and Engineering Designs for Egg Grading and Packing Plants

This long-term research, carried on at Davis, Calif., is directed toward the development of improved designs and layouts for small egg grading and packing plants, involving preparation of engineering drawings and development of building specifications. As large-scale commercial egg production units in the U.S. have increased in size and number, there has developed a need for structural designs and layouts for small egg grading and packing plants located at or near the source of production. These units will be designed to handle the output from one, two, or three large commercial flocks. Many of these plants are now located in buildings that were not designed for this type operation. As a direct result, the economic advantages that large lots of uniformly fine quality eggs offer through mechanized handling, are frequently lost, product quality is exposed to the hazards of improper environment, and labor and equipment utilization is poor.

Observations have been made in a number of plants typical of this category to determine production capacity requirements and desirable features of existing facilities. Because of urgent requests for assistance from industry, special emphasis is first being placed on the design and layout requirements for a small egg breaking room area required in these plants. A technical paper on egg products facility requirements was presented to industry representatives. An interim report will be prepared on the design and layout recommendations for small egg breaking operations.

Case study plants for overall evaluation will be selected and discussed with supervisory engineers and marketing specialists as structural designs are developed.

E. Improved Methods and Equipment for Eviscerating Chickens

This long-term research program, at Athens, Ga., involved the development of methods, operating procedures, and equipment for eviscerating chickens. Completion of this research involved publication of Marketing Research Report No. 651, "An Experimental Dual Track Conveyor System for Processing Poultry." It showed that through the use of the combination power and free

conveying principle together with an adaptation of mechanical line dividers, electrically operated carrier diverters, and convergers and temporary storage conveyor loops (all devised during the study); chickens can be routed through processing plant operations on individual carriers at changes in processing rates with less labor and a reduction in production "bottlenecks."

F. Improved Methods and Equipment for Cutting Up and Packing Chickens

This research, conducted at Athens, Ga., involves the study of the methods, equipment, and facilities for further processing chicken meat--cutting up whole ready-to-cook chicken and packing the output by individual parts, combination of parts, or as whole cut-up chicken--a merchandizing trend that currently involves about 1 billion pounds of chickens annually. Initial research in this area; carried out under research contract with the Gordon Johnson Equipment Co., Kansas City, Mo., in cooperation with the J. D. Jewell Co., Gainesville, Ga.; sought to reduce the relatively high labor requirements and costly losses sustained in frequently packing overweight in containers marked with the exact weight, by developing an accurate, rapid, mechanical weighing and selecting device for chicken parts. The results are now in manuscript form. They describe the development and testing of an experimental parts sizing and sorting machine that mechanizes the accurate selection of the last chicken part required to fill a container to an exact weight. Test results showed that it can reduce the amount of meat "given away" by $\frac{1}{2}$ ounce per 1-pound package and lower the packing labor requirements by 35 percent. The manuscript will be published as a marketing research report.

G. Improved Designs for Chicken Processing Plants

This long-term research, carried on in Athens, Ga., involves the development of guidelines for improved plant designs and layouts, furnishing maximum efficiency at minimum cost for new construction or plant modernization. The rapid growth of the poultry industry has resulted in building additions and frequently makeshift construction without sufficient regard to or utilization of space. New structures have frequently included errors in building design and plant layout because of an absence of basic guidelines. Designs and layouts for the basic plant work and service areas have been developed from a composite source of data--recommendations from recently completed research in the packing, eviscerating, and further processing areas, from review of approved blueprints of official U.S.D.A. plants, and from layout and design studies of plants that demonstrate effective utilization of plant space and personnel during current operations. A manuscript draft covering overall layout requirements, the layout of each work area, and development of plant designs directed toward efficient operation and economic expansion has been completed.

H. Improved Methods, Equipment and Facilities for Improving Chicken Processing Plant Efficiency Through Balance of Inspection and Eviscerating Operations

This study is part of a long-term research program carried out under a contract with the American Scientific Corporation at Alexandria, Va. Field studies are being conducted in selected chicken processing plants on the Delmarva Peninsula. It is directed toward increasing chicken processing plant efficiency and reducing the Department's costs in carrying out mandatory inspection in official U.S.D.A. plants. Research findings reported in MRR 549, "Methods and Equipment for Eviscerating Chickens" showed that maximum eviscerating crew labor utilization was reached at different production levels for certain combinations of equipment and crew sizes and composition. Extending production beyond these optimum rates not only decreases the output per plant worker, but frequently requires additional inspection personnel that is not fully utilized. Through the application of findings reported in MRR 549, and by conducting similar studies of inspection operations, analyzing production line speeds, types of equipment and processing crew makeup, guidelines for balanced operations will be developed for specified production levels while attaining maximum equipment and floor space utilization and maintaining an acceptable level of workmanship.

The first progress report covering the evaluation of the inspection operation in plants using specified conveying equipment, while operating at 1,000 to 3,000 chickens per hour, has been submitted by the contractor for review and acceptance. Optimum processing rates, inspection-eviscerating crew makeup and equipment combinations are predicted for specified production levels. After similar predictions are developed for plants operating in the 3,000 to 5,500 and 5,500 to 8,000 bird-hour rates, all predictions will be tested, adjusted as necessary, and a report prepared to provide guidelines for optimum crew (inspection and eviscerating) and equipment combinations.

I. Improved Methods and Equipment for Handling Live Chickens by Commercial Processing Plants

This research, carried on at Athens, Ga., involves studies of live chicken handling operations to determine the methods and equipment that cause the relatively high rate of bruising of live chickens prior to slaughter and to develop improvements that will minimize this costly damage that frequently results in "down grade" penalties to as much as 15 percent of a flock. In addition, efforts will be directed toward modernizing the equipment and methods so as to reduce the relatively high labor requirements and hazards of flock contamination. Preliminary studies of live handling and unpublished research findings indicate that broiler-class chickens respond favorably to the quieting effect of some types of external stimuli and could be useful in developing improved cooping methods and equipment as an aid to reducing "field" bruising. These possibilities will be explored as the analysis of existing methods and equipment is carried out. Interim reports will be prepared and published as the research progresses.

J. Improved Methods and Facilities for Chilling, Weighing, and Packing Turkeys

This research, carried on at Davis, Calif., is part of a long-term research program dealing with the development of improved methods, equipment and facilities for chilling, weighing, and packing turkeys and is similar to the research carried on in chicken processing plants at Athens, Ga.

Because of the relatively long time required to chill turkeys properly after evisceration, and the difference between this rate and the packing rate, the packing area in most turkey processing plants forms a "bottleneck" in product flow and is a direct cause of poor labor, equipment and space utilization. Further, operating procedures and equipment frequently permit sufficient "weepage" after weighing and packing so as to bring about short weight and unsightly wrapping stains. Because of the low projected return for their efforts, major equipment companies have not actively engaged in equipment development programs in this plant area.

This research is directed toward reducing the relatively high labor requirements for placing whole eviscerated turkey carcasses into their ultimate consumer package, minimizing weepage problems, and synchronizing these operations with the preparatory steps that precede them. Based on evaluation of existing operations through method analysis, improvements are being developed. A weighing-bagging station was designed and shop tested. Preliminary results indicate that it has the potential for reducing the physical effort required for this task and also reducing the crew size by two or more workers for packing turkeys on a 1,200 bird-per-hour production line. This equipment is now in the process of being field tested under commercial operating conditions. A report will be prepared setting forth the results of the tests, and will make comparisons with existing operations. Methods for reducing or eliminating other bottlenecks in the packing area are being considered and evaluated.

K. Improved Methods, Equipment and Facilities for Preparing Turkey Specialty Items

This research is part of a long-term program carried on at Davis, Calif. It is directed toward the development of guidelines for improved methods, equipment, and facilities for preparing many of the specialty items currently being marketed from cut-up ready-to-cook whole turkey. In recent years the trend toward preparing turkey specialty items in turkey processing plants designed only for slaughter, defeathering, evisceration and chilling has increased rapidly. Cut-up operations, deboning, preparing turkey logs and other specialties have frequently been carried on in overcrowded makeshift facilities, involving methods high in labor requirements and employing equipment of questionable value. This has resulted in production bottlenecks, hazardous to quality, and relatively high processing costs. Through process and method analysis, study of flow patterns and materials handling needs, improvements in work area layouts will be developed, and improved

methods will be developed, tested, and evaluated in order to provide an efficient economic preparation of product beyond the whole ready-to-cook turkey stage. Through industry contacts, access to typical plants has been established and a number of case study plants have been selected. As improvements are developed and tested, appropriate reports will be prepared.

PUBLICATIONS -- USDA COOPERATIVE PROGRAMS

Improved Methods, Techniques and Equipment for Cleaning Eggs

Brant, A. W. 1964. How You Can Wash Eggs Cleaner. A technical paper presented at the Fact Finding Conference, Institute of American Poultry Industries, Kansas City, Mo. Feb. 1964.

Improved Methods and Equipment for Eviscerating Chickens

Walters, R. E., Childs, R. E., White, H. D. 1964. An Experimental Dual Track Conveyor System for Processing Poultry. Mktg. Res. Rpt. No. 651. 24 pp.

Improved Designs for Wholesale Poultry and Egg Distributors' Warehouses

Hamann, J. A. 1963. Increased Efficiency for Poultry and Egg Wholesalers' Operations Through Plant Design Planning. A technical paper presented at the Annual North Central States Poultry and Egg Exposition and Conference, Omaha, Nebr. December, 1963.

Hamann, J. A., Forbus, W. R. 1964. Multiple Occupancy Warehouses for Poultry and Egg Wholesalers, Improved Designs. Mktg. Res. Rpt. 630. 39 pp.

Methods Equipment and Facilities for Grading and Packing Eggs

Hamann, J. A. 1964. Mechanized Egg Grading and Packing Lines. A technical paper presented at the Annual Meeting of the Poultry Science Association, University of Minn., Minneapolis, Minn. August 1964.

Improved Methods and Equipment for Cutting Up and Packing Chickens

Hamann, J. A. 1964. Mechanized Packing of Chicken Parts. A research report presented on WMAL and WRC television networks. January 1964.

Improved Layouts and Engineering Designs for Egg Grading and Packing Plants

Robbins, R. O. 1964. Facility and Equipment Needs and Layout Planning for Egg Breaking Rooms. A technical paper presented at the University of California Egg Products Workshop, Davis, California. June 1964.

AREA 7

CONSUMER PACKAGES AND SHIPPING CONTAINERS

Problem. It costs about 8 billion dollars a year to package food products, but without shipping containers and various other types of packages it would be impossible to move farm products efficiently from the widely dispersed areas of production through our complex marketing system to millions of consumers. New or improved packages and containers must be developed and evaluated to do this job more effectively. Continuing changes characterizes the American marketing system. In protecting, distributing and selling perishable agricultural commodities, packages and containers must respond to a number of marketing system changes. Such changes include:

- *Changes in consumer preference--from buying unpackaged items to buying in packages with convenience features such as ready-to-cook spinach.
- *Changes in distribution practices--from service grocery stores to self-service supermarkets.
- *Changes in forms of transportation--from surface to air where light weight containers are essential.
- *Changes in handling methods and equipment--from warehouse stacks as high as a man to multi-pallet stacks.
- *Changes in protective services--from water ice to vacuum cooling, which permits use of cheaper containers.
- *Changes in market organization--from buying at terminal auction to buying f.o.b. shipping point, which permits the economies of jumble-packing instead of costly face-packing.
- *Changes in market outlets--increased emphasis on selling many agricultural products in foreign markets.

Packages and containers not only respond to changes, but changes in them stimulate improvements in other elements of the marketing system. The job of the research program in this area is to see that packages and containers keep pace with changes in the marketing system and reduce the cost of handling, transporting and storing agricultural commodities. It also seeks to improve service to consumers, promote greater sales of farm products, and increase the income of producers.

USDA PROGRAM

This is a continuing program of applied research conducted by marketing specialists, industrial engineers, and agricultural economists to (1) develop new or improved consumer packages, master containers, packing materials, and shipping containers for agricultural products; (2) evaluate them from the standpoint of cost of materials and direct labor to pack, and their ability to reduce product damage and increase product salability; (3) determine at which point in the marketing system packaging can be done most effectively; (4) improve the efficiency of packaging methods to cut costs; (5) and investigate the needs for and benefits of container standardization and simplification. Current packaging and container research is concentrated for the most part in six commodity areas, each with differing needs: Deciduous fruits, citrus fruits, vegetables, potatoes, poultry, and dairy products. The program is carried on in cooperation with experiment stations and industry in California, Oregon, Washington, New York, Pennsylvania, South Carolina, Delaware, and Florida; at branch field stations in Orlando, Florida, Fresno, California, and Yakima, Washington, in other main producing areas, and in the principal terminal markets. This program involves 74 professional Federal man-years; (a) deciduous fruits, 2.9, (b) citrus fruits, 0.1, (c) vegetables, 2.0, (d) dairy products, 0.8, (e) poultry, 0.1, (f) cotton, 0.5, (g) program leadership, 1.0.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Deciduous Fruits

1. Peaches. Newly developed fiberboard and combination fiberboard and veneer wirebound boxes were found to offer savings in materials and labor costs of about 20 cents per 3/4-bushel of peaches. Bruising has been reduced from 12 percent in bushel baskets to less than 6 percent in the new boxes. Six million boxes were used last year which saved over a million dollars in the cost of marketing peaches. The field work on developing shipping containers for eastern-grown peaches was completed during the 1963 peach season, and a report has been prepared for publication.

2. Apples. Export containers--Several different containers of apples were test-shipped from Hood River, Oregon to London, England in December 1963. The containers evaluated were (1) the conventional tray pack fiberboard box - 5 layers of trays, (2) a three-layer tray pack fiberboard box (the U. K. apple industry has recently shifted to this size container), (3) five-layer tray pack boxes made from wax impregnated fiberboard (some outer cover only, some inner body only, and some with both inner and outer cases made of waxed fiberboard), and (4) shrink-film wrapped 2-1/2 pound consumer packages packed in a two-piece, full telescope compartmented fiberboard box.

The Red Delicious apples arrived in London with less damage in the consumer packages and the smaller three-layer tray packs, than in the full size tray packs, whether regular or wax impregnated board was used. The wax impregnated fiberboard box showed no obvious advantage strengthwise.

Loose-fill boxes--Little difference was found among four different containers for loose-fill or jumble-packed apples to protect the apples. The test containers were: (1) The conventional two-piece bulk or loose-fill fiberboard box; (2) the conventional box with ply-veneer sides added for greater rigidity; (3) the conventional box with a 3/4" rigid spacer placed in the bottom of the body; and (4) a one-piece box with a 14" collar-less web of 90-pound kraft paper laminated around the body. Bulging of the sides and ends of the box permitted the apples in all four test containers to settle in transit leaving head space and slackness. Greater box strength through better design or heavier board is still needed.

Master containers for bagged apples--An industry-developed compartmented master container was found more expensive than the conventional 2-piece full-telescope box because it held only nine 4-pound bags instead of ten 4-pound bags and because size of boxes prevented loading them in a standard rail car at the 40,000 pound minimum. The 2-piece full-telescope boxes also had greater stacking strength.

Cell and tray-packed Golden Delicious apples--More expensive waxed chipboard partitions did not show any improved performance over the unwaxed chipboard partitions for cell packed Golden Delicious apples. Chipboard partitions permitted more overhead pressure on the apples than the conventional double-face corrugated partitions, particularly as the length of time in storage increased. This was also true of the pulp trays tested, which rely on widely distributing the overhead pressures with staggered cups.

3. Evaluation of an experimental molded pulp deep pocket apple tray designed specifically for soft fleshed, bruise susceptible varieties such as McIntosh and Golden Delicious was continued. Improved tray and shipping container designs significantly improved the performance of this pack in a truck test shipment of McIntosh apples shipped from Maine to California. Successful development of this tray pack would save about 10 cents per box.

3. Pears. Four different packing patterns of placing consumer packaged Bartlett pears in shipping containers were tested, but no statistically significant difference in bruising or discoloration was found. A compartmented five-layer box, with vertical partitions, protected the consumer package appearance better than four-layer boxes with only horizontal layer pads. Packages stacked on their sides arrived in the worst looking condition because the pears shifted to one side of the tray, distorting both the film and the pulp trays.

During late March and early April of 1964, four commercial rail test lots of ripened D'Anjou pears were shipped from Yakima, Washington, to New York City. The purpose of these rail shipments was to determine: (1) The advantages and disadvantages of each of four consumer trays used for prepackaging pears; and (2) the advantages and disadvantages of three concepts of master shipping containers--a bulge and a flat pack with layer pads and a compartmented pack.

Differences in the consumer trays were found to be significant at the 99 percent level. One tray, designed specifically for prepackaged pears, was found superior to the other three trays that had been designed for apples and other round fruits. The longitudinal divider of the tray was the cause of most of the pear damage. Sharp ridges and gaps in these dividers need to be modified to reduce damage to pears.

The "bulge-pack" was found to be inferior for maintaining fruit quality as compared to the "flat-pack" and a compartmented box. The "flat-pack" master shipping container is recommended when pears are prepackaged and put in storage even though the pears settle and arrive slack in appearance, while the compartmented box is recommended as a shipping container for pears that are prepackaged for immediate shipment.

4. Grapes. Limited effort was devoted to: (1) Refining the design of a slit pyramid-shaped polyethylene bag developed by a package manufacturer. Experiments were conducted with the use of colored panels that would enhance the appearance of the grapes in combination with clear panels that would permit inspection of the grapes within the package. This package was also strengthened and its shape modified to fit grape bunches better; and (2) a preliminary evaluation of an extremely shallow consumer tray that provides a maximum of flexibility and visibility. These trays could be constructed of plastic or molded pulp. Initial results indicate that a complete film or mesh overwrap, rather than a band or sleeve wrap, is necessary for package strength. Preliminary test shipments of an industry developed full telescope fiberboard box in September 1964 showed some promise in offering good protection to the grapes and met with favorable trade reaction.

B. Citrus Fruits

Exploratory work on developing consumer-size packages for citrus fruits continued in cooperation with Florida growers and shippers. Limes, oranges, and tangerines were test-packaged in various types of consumer trays constructed from molded pulpboard and plastic materials in combination with transparent plastic. Preliminary test shipments of tangerines packaged in pulpboard tills overwrapped with a transparent film received favorable trade reaction at both receiver and retail levels.

C. Vegetables

1. Lettuce. Prepackaged lettuce--Test shipments and commercial shipments of lettuce prepackaged at shipping point have arrived in a condition as good as or better than conventionally packed unwrapped lettuce.

When lettuce is prepackaged at shipping point, about one-third of the weight of the lettuce shipped is eliminated by removal of the wrapper leaves. For this reason it costs about 30 cents less per box of 24 heads to ship wrapped lettuce from Salinas, California., to New York City.

Material and labor costs to prepackage lettuce at shipping point were 30 to 43 cents higher per box than to pack unwrapped lettuce. Higher development, overhead and capital expenses pushed the additional unit cost to about 50 cents--the premium usually charged for prepackaged lettuce. The cost of prepackaging lettuce at shipping point does not add to the total cost of marketing lettuce because the costs of performing these operations is merely shifted from the retailer to the shipper. Therefore, the chief net advantage in prepackaging lettuce at shipping point is the saving in transportation costs which could amount to several million dollars annually.

Some consumers, accustomed to soft films, did not like the hard feel of polystyrene in which most of the prepackaged lettuce was wrapped. To overcome this resistance, the use of softer films was explored. Polypropylene, polyethylene and polyvinyl chloride films were evaluated. These softer but less permeable films have not worked well under adverse quality and handling conditions that occur frequently in the lettuce industry.

Lettuce shipped by air freight--The economic feasibility of shipping lettuce by air freight was explored. The extra cost of shipping lettuce by air over rail is as follows:

Freight Rates - Salinas, California to New York, New York

<u>Type of Pack</u>	<u>Rail</u>	<u>Air</u>	<u>Difference</u>
Unwrapped lettuce in corrugated boxes (47 lbs.)	\$1.31	\$3.43	+ \$2.12
Prepackaged lettuce in corrugated boxes (32 lbs.)	.99	2.49	+ 1.50
Prepackaged lettuce in experimental paper bag-type shipping container (30.lbs.)	--	2.24	+ 1.25

By using an experimental paper bag as a shipping container, about 10 cents is also saved by lower container cost. The additional costs of shipping packaged lettuce in corrugated boxes by air as compared to shipping unwrapped lettuce by rail was \$1.18 per box--about 5 cents per head additional shipping cost.

2. Asparagus. A cheaper container for air freight shipments of asparagus was developed. Asparagus packaged in 1-1/2 pound waxed chipboard cartons was packed in a large combination fiberboard and wood shipping container. The capacity of the shipping container was 150 pounds and 96 packages were packed in it. Only one wax coated fiberboard layer divider supported by

three vertical fiberboard panels was used. The staples fastening the fiberboard to the wood pallet failed, indicating the need for improved fasteners and stronger fiberboard. If a container of this type could be developed, it would save about 50 cents in container costs and about \$1.00 in freight charges for the reduced weight. This would be equivalent to about 25 cents per crate.

3. Celery. Prepackaged at shipping point--A stretchable film sleeve wrap and a perforated polyethylene film bag for celery stalks were evaluated. The sleeve wrap left both ends of the celery stalks exposed. The polyethylene bag was left open so the stalks could be easily removed. Celery packaged in the perforated polyethylene bag showed significantly less moisture loss and had a better appearance than the non-packaged or sleeve wrapped celery. Also, a rail test shipment and a simulated laboratory test showed less bruising for celery stalks packaged in the polyethylene bags than for the non-packaged or sleeve wrapped stalks.

Crate for 14-inch stalks--A celery crate two inches narrower than the one most commonly used was evaluated to determine its practicability and acceptance. The new crate was designed to hold the same number of stalks as the conventional crate, but the stalks were trimmed to 14-inch lengths instead of the conventional 16 inches. Test shipments to eastern terminal markets showed that the total amount of bruising in conventional crates averaged 12 percent as compared to 10 percent bruising found in the new 14-inch crates. The leafy ends of the 14-inch stalks were more discolored and less attractive than the conventionally-packed 16-inch stalks. Although no container damage was observed for either container, the 14-inch crates appeared to be more compact and sturdy than the conventional crates. The trade reaction to the new crates was mixed. Some receivers failed to notice the difference between the 14-inch cut and the 16-inch cut. Some also commented that the 14-inch length did not leave enough stalk for retrimming. Potential advantages of using 14-inch crates include (1) lower transportation costs resulting from heavier loads, (2) savings in container costs, and (3) easier handling from reduction in gross weight.

4. Beans. The development and evaluation of consumer packages, master containers, and methods of prepackaging fresh pole beans was initiated during the 1964 marketing season. Various types of molded pulpboard, plastic, and chipboard trays overwrapped with shrinkable films and flexible bag packages were packed at shipping point to determine the best combination of materials and methods of packing them. The tray packages held from 1-1/4 to 1-1/2 pounds of fresh beans, and two sizes of polyethylene bags held 1-1/4 and 2 pounds of beans.

The experimental packages delivered the fresh pole beans in excellent condition. Reactions of the trade toward the packaged beans were mixed with some preferring the tray-type consumer units and others favoring the polyethylene bag packages.

Combined material and packing labor costs ranged from 5.9 to 7.5 cents per pound of fresh beans packaged in the rigid trays overwrapped with trans-

parent film; and from 3.9 to 4.8 cents per pound of beans packaged in polyethylene bags.

Fiberboard master containers were designed for shipping the experimental packages. The containers held 24 1-1/4 pound trays, 18 2-pound polyethylene bags, and 30 1-1/4 pound polyethylene bags.

D. Potatoes

No work currently in progress.

E. Dairy Products

A preliminary review of four packaging systems (bottle, can, coated carton, and bag-in-box) reveals that a great variety of milk packages of many different sizes and shapes has been developed, often with little regard for dimension compatibility within or between systems. This is complicated somewhat because bulk packages do not follow the usual practice of marketing milk in a series of binary or half-units. To show how compatible market units and dimensions can improve the marketing of milk, a series of six package models ranging from 1/2-pint to 2 gallons in size has been constructed. Like the bulk bag-in-box containers now in use, milk in this family of packages would permit its storage and handling with a 30 percent saving in refrigerated space required for bottles and cans. The package family offers the additional advantage of a full range of market units in compatible dimensions. A preliminary report is in preparation, describing the family of milk package models, and their possible use in an automated transportation system.

F. Poultry

Five types of clear shrinkable films were evaluated as wraps for cut-up chickens prepackaged and frozen in a Georgia processing plant. The prepackaged frozen birds were trucked to a Philadelphia warehouse and later put on sale in Wilmington, Del., food stores.

The films evaluated were: (1) 1/2-mil cast polyvinyl chloride; (2) 1-mil extruded polyvinyl chloride; (3) 1-mil irradiated polyethylene; (4) 1-mil polyethylene; and (5) 1-mil polypropylene.

Upon arrival of the packages at the retail stores, the 1/2-mil film showed substantially more tearing than the 1-mil films; among the four 1-mil films, differences in the incidence of tearing were not significant. All five films held up well while on display.

Although this was the first time that frozen cut-up chickens had been sold on a commercial scale in Wilmington, the shoppers bought more than had been expected, and as time went on, sales increased relative to sales of fresh chickens. The shoppers appeared to find no differences among the five test films, purchasing one about as readily as another.

G. Cotton (0.5 man-years)

In November 1963, an administrative report on all-cotton covers for U. S. cotton bales was prepared in cooperation with Cotton Division, AMS. The all-cotton covers used for the 1962 crop were compared with three types of jute covers commonly used in this country. The all-cotton covers weighed 12 pounds and were priced at \$4.80 per bale. The various jute covers were approximately the same weight, but their prices averaged \$1.54 per bale. Mixed shipments of bales were checked at gins and some were traced through shippers' warehouses and opening rooms at domestic textile mills. The all-cotton covers were neater in appearance, had less tearing and raveling, and stripped off more easily than the jute covers, leaving a cleaner surface on the opened bale. Information obtained was insufficient to quantify handling advantages for gins, shippers, or mills.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Vegetables.

Mallison, Earl D. 1964. Shipping Containers for Tomatoes. Paper presented at the annual meeting of the Ohio Vegetable & Potato Growers Association, Columbus, Ohio, February 5, 1964.

Chapogas, Peter G. and Stokes, Donald R. 1964. Prepackaging Lettuce at Shipping Point. Marketing Research Report 670, pp 48, July 1964.

Poultry.

Stokes, Donald R.; Kotula, Anthony W.; Mercuri, Arthur J.; and Buxton, Freeman K. 1964. Evaluation of Specified Shrink Films for Prepackaging Frozen Cut-up Chickens at Processing Plant. Marketing Research Report 662, pp. 15, July 1964.

General.

Stokes, Donald R. 1963. Improved Shipping Containers for Agricultural Products. Paper presented at the Fibre Box Association's Industry Growth Seminar, New York, New York, October 9-10, 1963.

Stokes, Donald R. 1963. How Good Packaging Benefits the Consumer. Paper presented at the annual meeting of the National Association of Marketing Officials, Brown Palace Hotel, Denver, Colorado, October 15, 1963.

Stokes, Donald R. 1964. Produce Packaging Prospects, 1964. Press release, September 1964

AREA 8

TRANSPORT EQUIPMENT AND TECHNIQUES

Problem. The cost of transporting farm products to market in 1963 was 5 billion dollars. Cost of transporting supplies used in farm production totaled more than one billion dollars. Further, costs of other marketing and production functions, such as loading and unloading vehicles, packaging storage and processing, also are affected by the efficiency of transport. These costs are important to the American farmer because they influence the return he receives from the sale of his products. They also are important to the American consumer because they influence the price he pays for his food. Therefore, the prosperity and efficiency of our entire agricultural industry and the economic well-being of the American consumer are closely tied to the efficiency of our transport system.

In spite of the importance of transport to agriculture and the consuming public, research to make it more efficient and less costly has been meager. New advances in transport and engineering technology, including the development of new materials, new building and operating techniques for transport equipment, containerization and unitization--all offer opportunities to improve agricultural transport. Translating these and other opportunities into working advantage for our agricultural producers and consumers requires a strong program of economic-engineering research. Such a program will help increase returns to American farmers, provide better products and lower costs to American consumers, and improve the competitive position of our farm products in foreign markets.

USDA PROGRAM

The economic-engineering research in this field is a long-range program. It seeks to develop improved transport facilities, equipment and techniques and more efficient ways of using them in transporting agricultural products and supplies. It is interdisciplinary in nature, drawing upon the training and experience of economists, mechanical and industrial engineers, marketing specialists and various other scientists. All the work is done with the cooperation of transport firms, transport and refrigeration equipment manufacturers and lessors, trade associations, State universities and experiment stations. Field studies are carried out throughout the U. S. and on overseas shipments. Only one field station, Orlando, Florida, is permanently maintained to support this research program. Part of the work is accomplished through research contracts and cooperative agreements.

At the present time work is underway in each of the following fields:

(1) transport equipment, (2) refrigeration equipment and techniques, (3) better utilization of transport equipment and techniques, (4) loading methods, including unitized loading, (5) development and evaluation of pallet containers, and (6) overseas transport.

This program of research involves 11.4 professional man-years apportioned as follows: Program leadership, 1.5; transport equipment 3.7; and transport techniques 6.2.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Transport Equipment

1. Thermal Rating of Refrigerated Trucks. This research is being conducted in cooperation with the National Bureau of Standards at the NBS facility in Washington, D. C. Its purpose is to develop a standard rating method to measure the thermal efficiency of refrigerated delivery truck bodies under conditions of 100° F. ambient, 50 percent ambient humidity, and 0° F. interior temperature.

Work was continued on the measurement of the rates of air exchange and the effect on load cooling caused by opening the door of a refrigerated truck. Preliminary tests were made using thermocouples, heat flow meters, and rapid response air flow probes designed and constructed at NBS. These instruments are used in conjunction with metered liquid nitrogen to maintain the steady-state interior temperature prior to the door opening and to restore the temperature immediately after the door is closed. Nitrogen from a self-pressurizing Dewar container is admitted to the interior through solenoid valves controlled by an air temperature multiple thermocouple grid. The heat load caused by the door opening can be determined by measuring the nitrogen required in excess of that required to maintain the steady-state temperature difference.

It is now anticipated that a final report will be issued during the next year.

2. Air Circulation in Refrigerated Trailers. The purpose of this research is to determine the most practical system for circulating cold air to obtain uniform temperature throughout a trailer load of frozen food. Previous tests have shown that temperatures at the front of a trailer near the cooling coils can be at 0° F. while other locations in the load may be several degrees above zero. This study seeks to find the best combination of blowers, air ducts, floor racks, and wall spacers to eliminate areas of high temperature. This is a cooperative program with the National Bureau of Standards being conducted at the NBS facility in Washington, D. C.

Work during the reporting period was devoted to analysis and reduction of the large amount of data obtained from previous trailer tests. Preliminary analysis of the tests comparing continuous and cyclic blower operation indicated somewhat greater load temperature changes during refrigeration "off" periods under the 12° F. thermostat differential, compared to 4° F. and 6° F. when the blower was operated continuously. The thermostat sensing element was located in the return air stream near the evaporator coils and behind a bulkhead near the front of the trailer. The space forward of the bulkhead warmed faster than the cargo space when the blower was cycled off. With the blower under constant operation under the refrigeration "off" cycle, the forward space warmed more slowly, at approximately the same rate as the cargo space.

The 12° F. thermostat differential produced exposed cargo surface temperature changes of about 10° F. when the blower was cycled and about 8° F. when the blower operated continuously. Center cargo temperatures changed about 0.5° F. in each case. All tests were conducted with ambient temperatures of 100° F. and mean interior (return air) temperature of 0° F.

3. Liquid Nitrogen Refrigeration for Frozen Food Trailers. The objective of this study is to determine whether it is practical to use liquid nitrogen as a refrigerant in vehicles transporting frozen foods. Previous research has shown that liquid nitrogen and liquid carbon dioxide will provide 0° F. temperature for frozen foods. However, analysis shows that these expendable refrigerants are more costly than conventional mechanical systems. This project is being discontinued until costs of expendable refrigerants are reduced sufficiently to make their use economically feasible.

4. Multi-Purpose Transport Vehicles. Van Containers--A design concept for a multi-purpose van container was developed during the year. It was described in a press release which generated widespread interest among steamship lines, railroads, freight forwarders, trucking groups, transport and refrigeration equipment manufacturers. Meetings were held with representatives of these groups and several offered to make available their facilities and technical assistance in engineering, construction and testing of the prototype van. An application for public-use patent on the van is now being processed.

The container can be used to haul both frozen and nonfrozen perishable products and nonrefrigerated cargo. It also can be used to carry freight by rail piggyback, highway, water (fishyback), and perhaps by air in moving farm products to the consumers.

Trailers--Research was begun late in the year to develop practical, low cost, conversion systems by which conventional refrigerated trailers and dry cargo vans can be made dual-purpose vehicles for use in transporting bulk as well as packaged cargo. It is being carried out under a cooperative agreement with the Oregon Agricultural Experiment Station. Several trailers

equipped with prototype conversion systems are now being tested in cooperation with several trucking firms in the Pacific Northwest. Initial results indicate that the rates of vehicle utilization are materially increased when the conversion systems are used. However, the project has not progressed far enough to obtain adequate data on vehicle utilization rates, operating costs, and revenue yields.

5. Improved Ventilated Piggyback Trailers. Research to develop improvements in rail piggyback trailers which will facilitate better product ventilation was continued during the year. Previous work showed that conventional highway trailers used for this service did not provide a flow of outside air through loads of perishables sufficient for adequate cooling.

Several trailers incorporating new ventilation systems were tested with shipments of watermelons from Florida to northern markets. One type van tested was equipped with adjustable scoops on the front ventilation doors to direct air into the van when hauled rear-end-forward on rail piggyback flat cars. Another type studied had under-floor scoops to direct air into the cargo area where the ram-effect forced it upward through the load and out the exhaust ports in the upper sidewalls of the van. The latter type trailer gave the best results. In paired tests the temperature of watermelons in a conventional van rose three degrees during transport while those shipped in the van with under-the-floor air scoops cooled 15 degrees. Additional work to develop further refinements in this system and to develop and test new equipment is being continued.

B. Transport Techniques

1. Pallet Containers for Transportation. All field work has been completed, the data analyzed and results evaluated on rail and truck shipments of apples in both expendable and reusable pallet containers of several different types. The initial report was extensively revised during the year. It is now being reviewed.

This research has shown that savings from using pallet containers of about 900 pounds capacity as compared to conventional 40 pound corrugated boxes range from 0.1 cents per pound, or about \$150.00 per carload for one trip to 0.2 cents, or approximately \$300.00 per car when the pallet containers are used for two trips. For some types of pallet containers greater savings may be made by using them for three or more trips. The economies in pallet container usage in transport result from lower container, packing, handling, freight and protective service costs per pound of fruit.

2. Loading Methods for Potatoes. Five air-flow loading patterns were developed to improve air circulation in motortruck shipments of bagged potatoes by providing a number of continuous longitudinal channels through the load. Tests results showed that when the trucks operated at approximately 50 miles per hour under ventilation, the average velocity of air movement

in the circulation channels ranged from 141 feet per minute to 274 feet per minute and the range over the top of the load was from 280 fpm to 472 fpm. Air movement through the channels caused temperatures throughout the load to change directly with the outside air temperature. The air moving through the channels also made it possible in some instances to remove excess moisture from damp potatoes. The new patterns are easy to load in any size vehicle and provide the trucker a full payload with proper weight distribution. The patterns are stable and remain intact during transit and do not increase container or product damage.

The report on this research has been submitted for publication. This project has been discontinued.

3. Heavier Loading of Watermelons. All field work has been completed, the data analyzed and results evaluated on all-rail and rail-piggyback shipments of long-type watermelons loaded 6 and 7 layers high compared with the conventional 4 and 5 layer loads. Additional data on freight costs were developed during the year and integrated with previously developed information on product damage, cooling rates and loading costs. The initial report has been revised and is being reviewed for publication. This project will be terminated after publication of the report.

This work demonstrated that shippers can take advantage of multiple-minimum or per-car rates to reduce transport costs through heavier loading provided proper precautions are taken to load only sound, disease-free melons of uniform size and shape. It was found that rail-piggyback shipments may be loaded 8 and 9 layers deep with substantially less melon damage than standard rail car shipments loaded only 6 and 7 layers deep. The use of piggyback trailers for delivery of melons to retail outlets has increased the flexibility of marketing, reduced handling costs, product damage and eliminated temporary storage of melons in wholesale warehouses and transport vehicles.

4. Loading Methods for Fresh Peas. The results of this study show that continuous stave baskets and the alternately inverted loading method can be used to reduce the amount of physical damage during rail transport. However, less refrigeration is obtained from top ice on the load when the crosswise offset pattern is used. Damage was also reduced and product refrigeration was not impaired when the amount of top ice was reduced by about half and half-stage bunker icing was used.

The report on this research is now being revised for publication during the coming year. This project will be discontinued.

5. Loading Patterns for Bagged Onions. More than 100 rail shipments of bagged onions from producing areas in Texas to eastern and midwestern markets were studied to obtain additional information on a new air-flow loading pattern developed in previous research. The new load pattern

provides more and larger channels which permit the air to move freely through the load. More of the air coming into the refrigerator car circulates through the load to help remove excess heat and moisture. This helps to prevent development of decay. One shipper adopted the new loading method for all his shipments which totaled more than 100 carloads. It is anticipated that other shippers will adopt the new method next season.

All field work has been completed. The data will be analyzed and results evaluated, and a detailed report prepared for publication during the coming year. This project will be discontinued.

6. Loading Patterns for Fiberboard Citrus Boxes. A modified bonded-block stacking pattern for corrugated fiberboard boxes was developed and has been tested for three shipping seasons. The pattern provides inter-connecting channels throughout the load to allow air circulation to each box of fruit. Air circulation through the new load was improved in both ventilated and refrigerated shipments. Product temperatures were maintained nearer the recommended levels during transportation. The new pattern is easy to load and is adaptable to any size trailer. Good row and stack alignment are maintained during transport and commodity and container damage are held to a minimum. It is estimated that more than 90 percent of all Florida oranges and grapefruit packed in the 4/5-bushel corrugated box are stacked in this way for transport by truck and rail piggyback.

A report on this research has been submitted for publication. This project will be discontinued.

7. Unitized and Palletized Transport. A literature review of systems analysis and operations research applications to the handling and transporting of agricultural commodities was completed during the year. This information has been used to plan work in which this research technique will be used to evaluate different methods of unitized and palletized transport.

Observations were made of the operations of handlers and shippers of carrots in California, Arizona, and Texas to determine the feasibility of applying systems analysis and operations research techniques to improve transport and handling of this product. Data developed in this survey have been used to construct a "word model." This model may serve as the basis for constructing a mathematical model which can be used to predict the results of changes in any part of the transport system for a particular product.

8. Overseas Transport. Studies were made of four ways of shipping fresh beef to European markets. These were refrigerated van containers, American flag refrigerated holds, foreign flag holds, and banana boats. Commercial beef shipments from packing houses in the industry to European markets in refrigerated van containers were observed. One van delivered the meat in fair condition, while the beef in the other van was in poor condition.

Experimental methods of shipping fresh hanging beef in refrigerated holds also were tested in comparison with the established military method of stacking the fresh beef on the hold's floor. One demountable rack system proved far superior to any other method of shipping in refrigerated holds. With this method a greater payload was delivered in better condition, at a cost slightly less than floor-loaded beef.

Information on marine insurance, transport and handling costs for containerized and noncontainerized overseas shipments of agricultural perishables was developed during the year. An analysis is now being made of this information and data on product cooling rates, damage, and spoilage developed in last year's shipping experiments to overseas markets. An interim report on work is being prepared for publication during the coming year.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Transport Equipment

Guilfoy, R. F., 1963. Liquid Carbon Dioxide Refrigeration in a Frozen Food Trailer. November 1963. AMS-522. pp. 15.

Clayton, J. E., 1964. USDA Transport Research--Past and Future. Paper presented at the National Conference on Handling Perishable Agricultural Commodities, Purdue University. March 1964.

Guilfoy, R. F. 1964. USDA Research in Transportation of Fresh Meats. Paper presented at the National Conference on Handling Perishable Agricultural Commodities, Purdue University. March 1964.

Guilfoy, R. F., 1964. Transport of Perishable Foods. Paper presented at the Annual Food Engineering Conference, Michigan State University. April 1964.

Transport Techniques

Press release, 1964. New Van Container Concept Developed by USDA. June 1964.

Hinds, R. H. and Robertson, J. K., 1964. Air-flow Loading Patterns for Truck Shipments of Early Potatoes. September 1964, MRR ____.

AREA NO. 9. RETAIL FOOD STORE OPERATIONS

Problem. There are about 320,000 food retailing establishments in the United States which market over two thirds of all farm products, representing about 64 billion dollars of sales. Of these there are 230,000 grocery stores carrying a complete line of food. The cost of retailing is over \$10 billion annually and required about 18 percent of the consumers dollar spent for food in 1963. The labor cost alone in these stores represents approximately \$5 billion a year for the 1,800,000 employees.

A number of developments accelerate the need for more research in this area. Increasing wage rates and material costs require constant improvement in management if retailing costs are to be held down. Retail food stores are carrying a steadily increasing number of food products, which, by competing with existing lines, lower individual product volume and increase item costs. In addition the competitive pressures of new supermarkets have caused a decrease in sales per square foot of space, thereby, adding to the costs. As a result the increases in efficiency of individual food stores seems to be slowing down. Dramatic changes appear to be necessary to create new savings, however, most firms are too small to afford expensive research or trial and error experimentation, others need to be shown that research is effective.

USDA PROGRAM

The Department has a continuing long range program of research utilizing marketing specialists, engineers and personnel with other skills to develop improved work methods, equipment, materials, layout and operating procedures for retail food firms. This work is carried on an informal cooperative basis with Federal and State Extension Services, other governmental agencies, State Departments of markets, trade associations, and with members of private industry. Contracts are used for some projects and some research grants are received from private industry. The program includes the utilization of various means of disseminating the information to the separate firms by such tools as motion pictures, clinics, speeches, and similar means.

The federal professional man-year effort devoted to this research totaled 7.0 years, and of this number .5 man-year was devoted to program leadership, 2.7 man-years were devoted to meat, 2.0 man-years were devoted to dairy, bakery and frozen food, 1.3 man-years were devoted to produce, and .5 man-year was devoted to store operations and facilities.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Meat

1. Central preparation and packaging of fresh meat and poultry products for retail sale. The objective of this research is to increase the efficiency of processing, handling and packaging fresh and frozen meat and poultry products in corporate, voluntary and cooperative chain managed centralized processing plants. Processing of retail cuts of fresh meat in a central plant for a group of retail stores can save thousands of dollars annually in construction, equipment and labor costs--as much as \$650,000 for a group of 40 stores with a yearly meat volume of 13 million dollars. These savings were projected from results obtained by research in smaller central plants. One firm has constructed a central plant based on this research which now serves 7 supermarkets. After two years of operations his costs have equaled about exactly those projected in the report. The report entitled "Centralized Processing of Fresh Meat for Retail Stores--An Interim Report" was released in October 1963. Since then copies have been distributed. Research into layouts and procedures for large plants has continued and several larger firms are now considering the system. In addition research on retail store operations has been conducted to evaluate how store level personnel should be utilized in order to encourage meat sales and satisfy customer requests. A color sound motion picture has been developed filming this operation and distributed extensively by Kansas State University.

2. Packaging and price-marking meat and poultry in retail food stores. This project is designed to develop new and improved work methods, equipment, materials, layout and operational practices for packaging and price marking in retail meat departments.

Researchers have evaluated several different types of wrapping machines and have concluded that it is economically feasible to install semi-automatic meat packaging machines in retail food stores which have a weekly volume of \$3,000 in fresh meats. They have also determined it is feasible to install fully automatic meat packaging machines in retail stores with a weekly volume of \$5,400 in fresh meats. A draft of a report on meat wrapping machines has been prepared but will **not** be released until some additional information on wrapping supplies has been obtained. These additional studies will include analysis of wrapping films other than cellophane.

3. Tray display for meat, poultry and delicatessen products in retail stores. This project is concerned with improving the effectiveness of meat displays. Preliminary studies indicate that location of the product in the display cases may be even more important than space allocation itself. Studies also show that additional space above a certain minimum display had little affect on sales for beef and delicatessen items, but did seem to increase sales for pork. Research is being conducted on product movement, in nine stores in two firms. Analysis of these records shows the meat manager can more effectively price the merchandise, reduce rewrap cost,

schedule labor and production, and order more efficiently when using past daily movement records. This project is behind schedule for lack of personnel and will require additional field research before findings can be confirmed.

4. The effect of improved techniques of sanitation and temperature control in retail processing of meat. The purpose of this research is to determine if added shelf life, improved product quality or increased operating efficiency can be obtained in retail meat departments by providing closer adherence to optimum temperature and sanitation conditions than that generally followed by the industry. The study also attempts to determine to what degree added emphasis on temperature and sanitary conditions will affect costs. This project is being conducted in part through a contract with the University of Missouri, jointly administered by the Market Quality Research Division and the Transportation and Facilities Research Division of ARS. A manual listing most of the known facts about sanitation, temperature and shelf life has been prepared and reviewed extensively. The manual will be published this year.

A series of laboratory tests of different degrees of sanitation and temperature levels involving 10 beef cycles and 10 pork cycles are completed and being analyzed. Eight cycles of lamb will begin September 25. Preliminary analysis of data indicates that light and display case temperature effects have been reasonably isolated and measured. Sanitation levels appear not to have given significant differences in shelf life.

B. Produce

1. Preparation and packaging of produce at the central warehouse. The purpose of this project is to improve and evaluate the cost of central warehouse produce packaging and to make a comparison with other locations for produce packaging. The use of relatively large pallet containers which hold from 750 to 1,300 lbs. of apples, citrus and potatoes will result in a potential savings of \$59,000 to the firm which on the average produces 70,000 packages per week. The labor requirements for receiving at the warehouse are reduced by 91 percent with the use of pallet containers. A one-way feed belt with adjustable product diverters used in conjunction with hopper type baggers is an effective way of packaging all types of bag type items. The rotary bagger is very effective for potatoes but will bruise apples. A tape closure which is date coded is the recommended material for bag closures.

The most effective returnable container for warehouse to store shipment was of polyethylene plastic, held 60 lbs., would rest and stack and last 5 years. As compared to the use of salvage boxes this container would save \$17,000 per year.

A system of scheduling and cost control was developed for the produce packaging operation. There is a potential savings of 28 cents per retail unit or \$102,000 per year to the firm which produces 70,000 bags per week at the central warehouse.

Packaging bananas in a sleeve of shrink film at the warehouse showed potential savings of 25 cents per 40 lb. box as compared to selling unwrapped bananas from bulk displays in the retail store. There was no evidence of increased banana sales in the eight stores over a 4-week period. The savings were due to reduced shrinkage. Waste at the retail store was twice as high for the bananas displayed loose and cost 9.2¢ more per box than those prepackaged. Markdowns were 4.5 times higher for the bananas displayed loose. The total loss in shrinkage at the retail store was 15.9¢ for prepackaged bananas and 41.4¢ for loose bananas in bulk displays.

A manuscript on central produce bagging is currently undergoing departmental review.

2. Alternative techniques for handling produce in retail food stores.

This is a long term project making use of detailed studies from a number of stores operating bulk or prepack produce departments with variations in each method of operation. Productivity records, shrink, cost and selling prices and sales results are put on IBM cards in order to evaluate different product mixes and methods of operation. The project has not been active during 1963-64 due to lack of funds and personnel. When personnel are available effort will be made to find a cooperator with adequate data processing machine capacity to operate this system as part of the general accounting procedure for the firm.

C. Dairy, Bakery, and Frozen Food

1. Improved methods, operating practices, equipment and materials for the dairy operation in retail stores and central warehouses. The purpose of this project is to increase the efficiency of wholesaling and retailing dairy products through the analysis and development of improved work methods, equipment, layout, delivery methods, customer shopping patterns, and internal operational and management practices.

Studies of the effect of display fixtures on sales in 12 stores showed there was no significant difference between cases. The rear-fed display cases required 16 percent less labor than the conventional multi-shelf display cases for dairy products. Based on labor requirements, depreciation, operating costs, and space charges the reach-in (rear-fed) display case cost \$409 less than the air curtain installation and \$205 less than a multi-shelf case. The rear-fed "downflow" system will reduce cost for selling milk and insure rotation. The wire basket system of handling and displaying eggs will save \$180 in an average size dairy department. A new order form which incorporates a history of past sales will reduce inventory and insure against out-of-stocks.

The packaging of bulk cheese at the central warehouse is 37 percent less costly than at the retail store. The cost of the cutting function alone is reduced by 56 percent at the central plant. Labor costs were reduced by 84 percent by use of the automatic gas-flush packaging system compared to manual wrapping at the warehouse. Although the gas-flush had relatively high material costs the combination of added shelf life (up to 30 days), low labor costs, and high rate of production made it a very desirable system when used in conjunction with a manual assembly line for odd shaped packages which cannot be packaged by machine. "Catch-weight" packages are preferred to a system of "exact-weight" packages. A returnable container will save 3.6 cents per trip as compared to expendable corrugated containers.

A report entitled "Improved Handling of Dairy Products in Retail Food Stores" was published during the year and a report on the packaging of bulk cheese is now in the process of being reviewed by the Department.

2. Improved retail bakery department methods and practices. The purpose of this research is to increase the efficiency of retailing bakery goods through the analysis and development of improved methods, procedures, equipment, materials and layout for service and self-service retail bakery departments and in-store baking facilities. Detailed time, cost and sales records were obtained from 2 self-service type bakery departments and 2 service type bakery departments in 4 supermarkets. A service type retail bakery department typically consists of a service and a self-service section. A self-service retail bakery department consists of only a self-service section. Labor costs for operating a service type bakery were 3.1 cents for each unit of bakery product sold and in the self-service type bakery the costs were 2.4 cents. In retail stores having a service type bakery department, the labor costs for processing and selling each unit sold in the service section was nine cents as compared to one cent for each unit sold in the self-service section. Sale of demand items (bread and rolls) accounted for 76 percent of bakery sales in the self-service type and 60 percent in the service type bakery departments. The service section of the service type bakery sold a greater percentage of the higher margin impulse items. The percentage of bakery products that were not sold within their specified shelf life and were classified as stale products varied from 7 to 16 percent of bakery sales in four stores. An effective method of merchandising the stales in one firm allowed them to recover 68 percent of the original retail prices.

A report, "A Survey of the Bakery Department in Retail Stores," is now in departmental review.

D. Store Operation and Layout

1. Increasing the efficiency of small stores, superettes, and supermarkets through the adoption of research results. This project is designed to increase the efficiency of food retailing through the further development of research results to broaden their adaptability to stores of varying

size, ownership control, location, and other individual characteristics with special emphasis on the superettes or neighborhood type store. Work was continued on a series of manuals in cooperation with the Federal Extension Service designed to assist retailers in adoption of research results and three additional manuals were published. The produce manual series now contains 8 publications covering the produce department operations. A series of small store installations and assistance programs have continued. A series of training clinics were conducted covering such subjects as warehousing, produce handling, meat and grocery operations, management and layout. Educational exhibits were maintained at 5 national trade association conventions.

The Federal-State Extension Service cooperated closely with the Wholesaling and Retailing Research Branch in getting research results adopted by the food distribution industry. Some of the results reported during 1964 are as follows:

Delaware

The Sixth Annual Delaware Conference on Food Distribution was held on March 31 through April 2, and was the highlight of the entire year's Food Distribution Program with food brokers, wholesalers and retailers. Attended by some 200 food distributors, this year's program of 20 workshops and four general sessions stressed importance of analyzing management and operational functions in order to profitably compete in today's era of low margin competition.

Produce display and backroom preparation areas of two supermarkets were analyzed during the year and recommendations for improved layouts were given. A flow study was performed in one produce backroom and three possible improved layout arrangements were developed. These improved layouts are expected to save the operators approximately \$4,000 a year.

Illinois

In November of 1962 a perishable warehouse study was made in cooperation with the Wholesaling and Retailing Branch, ARS. The preliminary report was made to the company executives in December 1962. The final report of this study was submitted February 1963. During this period, all recommendations for improving this perishable warehouse had been checked. To date approximately 75 percent of the recommendations for improvement have been made. Over the past two years this operation has been visited by thousands of representatives from many companies throughout the United States. In adopting this efficiency study the company saved thousands of dollars.

Indiana

An Indiana owner-operator (member of a large voluntary group) opened his second market in a small Indiana town in November 1961. This market,

however, had trouble showing a profit from the beginning and had lost nearly thirty-six thousand dollars by July 1963 at which time the Extension Service was contacted. As a result, by November 1963 this store was beginning to show a slight profit with excellent prospects of earning a reasonable return on investment in 1964. Management attributes this financial recovery to the Purdue efforts.

Massachusetts

Massachusetts Extension specialists completed the production of a frozen food training film during early 1963. This film was produced under contract with the Federal Extension Service of USDA, and it was based upon the results of research conducted by ARS and studies conducted by the University of Massachusetts in cooperation with food distribution firms.

New Hampshire

A New Hampshire supermarket that adopted changes recommended by the Extension specialist in the produce department increased produce sales from 5.7 percent of total sales to about 7.0 percent of sales. Sales per man hour have also increased from \$15.83 to slightly over \$20.00. Inventory turnover has also increased by one-third.

Oklahoma

An analysis of work methods in an Oklahoma wholesale grocery company by the Extension specialist resulted in a complete reorganization in warehouse layout. Merchandise was located according to velocity, weight, and bulk. A short selection line was installed where selectors are permanently assigned specific warehouse areas. This has resulted in the elimination of two selectors and an increase in output of 1.5 tons per man hour.

Puerto Rico

Extension Service specialists aided retailers in Puerto Rico to initiate the organization of three retailer-owned wholesale operations. Although still in a development stage and facing problems common to this type of organization, the three retailer-owned groups are well over the break-even point. About 150 grocers are members of these firms with combined assets of over \$250,000. Sales of \$2 million were estimated for the last year.

2. Optimum work methods, equipment, layout and store organization for the total retail food store. The purpose of this project is to increase the efficiency of the entire food store operation by combining through the use of operational research techniques the results of past research developed in the various departments of the store. The research has not been initiated because personnel were not available. The first phase of the study will be the development and installation of the produce model under line

project TF 5-20. This model will be expanded to include other departments of the store. The second phase will be the review of work standards for all departments of the supermarket and if necessary the updating of the standards and relative cost data. The project will be reviewed by industrial research firms and universities. A contact may be undertaken for phases of the study which require more advanced research techniques.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Meat

Anderson, Dale L. 1963. Central Packaging of Meat. Paper presented at National Association of Food Chains Annual Convention, New York. (Processed)

Trieb, S. E. 1963. Kansas Grocer Cuts Costs With Central Meat Plant. The Kansas Agricultural Situation, pp. 7 and 8.

Volz, Marvin D., and Marsden, James. 1963. Central Processing of Fresh Meat for Retail Stores--An Interim Report. Marketing Research Report No. 628, 76 pp.

Volz, Marvin D. 1963. Scheduling and Record Keeping in Processing Fresh Meat Centrally. Paper presented to Fourth Food Distribution Research Conference, Lansing, Michigan. (Processed)

Produce

Anderson, Dale L. 1964. Produce Department Management. Paper presented at the 7th Annual Delaware Conference on Food Distribution, Newark, Delaware.

Anderson, Dale L. 1964. Customer Service for Retail Produce Departments. Marketing Bulletin No. 32, 12 pp.

Anderson, Dale L. 1964. Produce Display Work Methods in Retail Stores. Marketing Bulletin No. 33, 24 pp.

Anderson, Dale L. 1964. Produce Sales Area Arrangement for Retail Stores. Marketing Bulletin No. 34, 12 pp.

Shaffer, Paul. 1964. Central Produce Packaging. Paper presented to NARGUS Produce Merchandising Clinic, Chicago, Illinois. (Processed)

Dairy, Bakery, and Frozen Food

Flynn, Gordon. 1964. Improved Handling of Dairy Products in Retail Food Stores. Marketing Research Report No. 661, 24 pp.

Store Operations and Layout

- Anderson, Dale L. 1963. Research Challenges of the Future for Food Wholesaling and Retailing. Paper presented to Kansas State Retailers Convention, Wichita, Kansas. (Processed)
- Anderson, Dale L. 1964. Innovations in Food Distribution. Paper presented to NAWGA Perishables Workshop, Ashville, North Carolina. (Processed)
- Anderson, Dale L. 1964. Approaches to Cost Reduction. Paper presented to University of Maryland Food Distribution Conference, College Park, Maryland. (Processed)
- Anderson, Dale L. 1964. Retailing Around the World. Paper presented to the University of Maryland Food Distribution Conference, College Park, Maryland. (Processed)
- Anderson, Dale L. 1964. Changes in Wholesaling and Retailing. Paper presented to National Association of Produce Market Managers Convention, Louisville, Kentucky. (Processed)
- Anderson, Dale L. 1964. Basics of Store and Backroom Layouts. Paper presented to 12th Annual Purdue Food Retailers Clinic, Lafayette, Indiana. (Processed)
- Hoecker, R. W. 1964. Supermarkets Around the World. The Yearbook of Agriculture, 1964, 3 pp.
- Hoecker, R. W., and Anderson, Dale L. 1964. The New Revolution - Centralization of Food Store Processing. Paper presented to Super Market Institute Annual Convention, Chicago, Illinois. (Processed)

AREA NO. 10. WHOLESALE FOOD OPERATIONS

Problem. More than 7,000 grocery and perishable food items are handled through modern integrated warehouses supplying retail food stores. Wholesaling requires an estimated 8 percent of the consumer's dollar and, along with retailing, constitutes about 50 percent of the costs of marketing food. Effective wholesaling reflects itself not only in lower wholesaling costs but also in lower consumer prices. The efficiency of warehouse handling and delivery of groceries, produce, meats, and frozen foods, and of warehouse office procedures, can be increased by the development and adoption of improved work methods, equipment, layout, and organization. Research is also needed to develop coordination and improved materials handling methods between manufacturers and warehouse distributors. The need for research in these areas is accelerated by increasing wage rates and technological advances. The operating problems in the modern integrated warehouse are becoming increasingly complex due to the increased number of items handled by the modern supermarket and the increased proportion of products that are being handled through the central warehouse. Increased efficiency will help reduce the costs of warehousing and delivery operations, improve the quality of the product sold; increase the quantity sold; and increase the returns to producers.

USDA PROGRAM

This is a long-term program of operational-type research, incorporating industrial engineering and marketing research techniques, designed to increase the efficiency of distributing food products at the wholesale level. It may be broadly divided into three areas of activity: (1) Grocery warehouse operations; (2) perishable products warehouse operations; and (3) cost control and office procedures. Research in the grocery warehouse is concerned with improved warehouse layout, equipment, work methods, and reduced breakage and damage. The perishable warehouse operations research is designed to develop improved layouts, work methods, and equipment to reduce the cost of handling produce, meats, dairy and delicatessen, and frozen foods through the warehouse and in delivery operations. Research on cost control and office procedures includes work designed to increase the efficiency of order taking, accounting, and inventory control. The program includes numerous methods for disseminating research results to firms including use of such tools as motion pictures, clinics, and speeches. Close working relations are maintained with the cooperative Federal-State Extension Service where specialists in numerous states are active in disseminating research.

The federal professional man-year effort devoted to this research last year totaled 2.9 and of this number .2 man-year was devoted to program leadership, .2 was devoted to grocery warehousing and delivery, 1.0 man-year was devoted to produce and meat warehousing, and 1.5 man-years were devoted to wholesale warehouse cost control and office procedures.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Grocery Warehouse Operations

1. Breakage and damage in warehouse and retail stores. A study was completed in 3 grocery warehouses and 6 retail food stores to identify causes of grocery damage. A report entitled "Breakage and Damage in Grocery Warehouses and Retail Food Stores" was published in May 1964. Breakage and damage losses in food stores and warehouses in the U. S. would amount to over \$35 million annually if the firms studied were typical. The report gives causes and steps to correct and recoup losses from breakage and damage.

B. Perishable Products Warehousing Operations

1. Selected methods for loading out delivery trucks with produce. A study was completed evaluating three methods of order assembly and loading of delivery trucks with produce. The three methods included the use of a tow tractor and 4-wheel trucks to assemble individual orders, a motorized belt conveyor with recorder and transcriber, and a motorized belt conveyor and checker system. The motorized belt conveyor with recorder and transcriber was less costly than other methods for the assembly and loading of individual orders less than 37 packages in size. This system is particularly suited for wholesalers supplying hotels, restaurants, and small retail stores. For wholesalers supplying orders larger than 37 packages in size, such as corporate chain stores, voluntary group stores, and cooperative group stores, a system using tow tractors and 4-wheel selector trucks for order assembly is less costly. A research report entitled "Three Methods for Loading Out Produce in Warehouses" was published in June 1964. A second report entitled "Improved Produce Handling Methods in Affiliated Warehouses" is in the process of being cleared. This work was conducted in cooperation with the Handling and Facilities Research Branch.

2. Integrated fresh meat operations at the wholesale level. Studies have been conducted of the warehousing methods and practices and opinions of operators of 5 fresh meat and delicatessen warehouses. Methods and opinions were also studied in 6 firms using a packer shipment program for supplying integrated retail stores. Prior to the adoption of a packer-shipment program one group of affiliated retail stores bought meat from 17 packers, whereas with the adoption of a packer-shipment program orders were concentrated with only 2 packers. The firms indicated retailer costs for fresh meat averaged 3 1/4 cents per pound less with an integrated wholesaler meat warehousing program than when retailers purchased directly from packers. However, a wholesaler should handle a minimum of 150,000 pounds of meat a week and have strong buying loyalty on the part of his retailers before entering into a meat warehousing program. Retailers indicated their savings with a packer-shipment program over direct purchases from packers were approximately 1 cent per pound. An evaluation of the relative merits and costs with each type of program is prepared in draft form and will be published during the coming year.

C. Cost Control and Office Procedures for Wholesalers

1. Uniform financial reporting. An improved chart of accounts and accounting methods have been developed and published by the Department. Work was conducted under contract to secure the adoption of this chart of accounts in 100 voluntary group, cooperative group, and independent food distributors. Wholesalers represented by this group supply food products to retail food stores doing more than 60 percent of the \$60 billion food store sales in the United States. Standards and ratios will be developed to measure efficiencies in the use of capital, labor, facilities, and equipment. The study will establish a basis for developing industry costs in food distribution. Participating firms paid half the cost of this research project. Part of this work was accomplished by contract. A total of 69 firms have signed a memorandum of agreement to participate. It was particularly difficult to obtain cooperation from the smaller size firms. This study was conducted in cooperation with the Marketing Economics Division, ERS. Results of the study will be published during the coming year.

2. Inventory control and warehouse space allocation. A detailed study was conducted in one wholesale grocery warehouse to determine more effective ways of maintaining satisfactory inventory levels. The study will apply to wholesale grocery firms whose annual business volumes are not large enough for the firm to afford computer type data processing equipment. Data collected from the one firm showed one percent, or 45 items, accounted for 25 percent of the total sales in 1963. Methods are being tested to help the wholesaler determine the most economical order quantities and reorder points for items handled by these vendors. This research project is being conducted under a cooperative agreement with General Foods Corporation and with the Market Development Branch, ERS. Findings under the study will be published during the coming year.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Grocery Warehouse Operations

Bouma, J. C. 1963. Planning for Profits in Grocery Warehousing. Paper presented at Food Merchandisers of America, Mid-Year Meeting. (Processed)

Bouma, J. C. 1964. Current Research on Wholesaling in the U. S. Department of Agriculture. Paper presented at Texas Wholesale Grocers' Association Annual Convention. (Processed)

Bouma, J. C. 1964. The Revolution in Food Wholesaling and Retailing. A Program Designed to Develop Agricultural Resources Effectively. Sponsored by the University of Florida. (Processed)

Hoecker, R. W. 1964. What a Modern Food Distribution Center Should Be. Paper presented at South Eastern Cooperative Food Distributors Meeting. (Processed)

Karitas, J. J. 1964. Breakage and Damage in Grocery Warehouses and Retail Food Stores. Marketing Research Report No. 652, 63 pp.

Taliaferro, W. C. 1964. Principles for Improved Grocery Warehouse Operations. Paper presented at Retail and Warehousing Operations Research Clinic. (Processed)

Perishable Products Warehousing Operations

Lundquist, A. L. 1964. Produce Warehouse Operations. Paper presented at Retail and Warehousing Operations Research Clinic. (Processed)

Lundquist, A. L. 1964. Fresh Meat Warehousing and Packer-Shipment Programs. Paper presented at Retail and Warehousing Operations Research Clinic. (Processed)

Lundquist, A. L., and Bouma, J. C. 1964. Three Methods for Loading Out Produce in Warehouses. Marketing Research Report No. 665, 44 pp.

Lundquist, A. L. Produce Warehouseman - Is Your Loading Out Method Efficient? Agricultural Marketing, July 1964, pp. 4 and 5.

Cost Control and Office Procedures for Wholesalers

Bouma, J. C. 1963. Uniform Accounting for Institutional Wholesale Grocers. Paper presented at Institutional Food Distributors of America Workshop. (Processed)

Bouma, J. C. 1964. Accounting Techniques and Systems for Wholesalers. Paper presented at Retail and Warehousing Operations Research Clinic. (Processed)

Bouma, J. C. 1964. How to Spot Your Profit Leaks. Paper presented at Institutional Food Distributors of America Convention. (Processed)

AREA NO. 11. INSTITUTIONAL FOOD SERVICE OPERATIONS

Problem. Approximately one-fifth of the food consumed in the United States is distributed through institutional outlets. These outlets, including hotels, restaurants, schools, hospitals, and in-plant feeders have been affected by rapidly rising operational costs with little research being conducted for the purpose of offsetting these higher costs with increased efficiencies. Preliminary studies in food service kitchens indicate that substantial efficiencies can be effected through improved work methods, equipment, layout and management practices. Research in the area of central food preparation may also provide a method for substantially reducing the costs of institutional food distribution.

Whereas, the efficiently operated grocery wholesalers supplying retail stores have reduced their margins since 1950 from about 12 percent to about 6 percent, institutional wholesalers' margins have remained at 18 to 20 percent. Although characteristics of the institutional wholesaler grocery business are such as to prevent margins of 6 percent, a realistic goal would seem to be 10 percent. It is realistic to visualize considerable savings in institutional operations from research with institutional wholesalers.

USDA PROGRAM

This is a long term program designed to increase the efficiency of distributing food through institutional channels. It may be broadly divided into two areas of activity: (1) The wholesale distributor, and (2) the food service operation. Research at the wholesale level is concerned with the improvement of warehouse layout, work methods, office procedures, delivery methods and improved services to food service operators. Food service research is directed towards increasing operational efficiency of food service outlets, including school lunch operations, through improved layout, work methods and procedures. Changes in program emphasis at both the wholesale distributor and food service levels will occur as areas of savings are evaluated.

The federal professional man-year efforts devoted to this research totaled 3.0 and of this number .3 man-year was devoted to program leadership, 1.9 man-years was devoted to institutional grocery warehouse operations and improved services to food service operators, and .8 man-year was devoted to operational efficiency of food service outlets and school lunch kitchens.

REPORT OF PROGRESS FOR USDA AND COOPERATIVE PROGRAMS

A. Institutional Wholesale Food Distribution

1. Improving operations in institutional grocery warehouses. One institutional wholesale grocery firm has been selected to serve as a model for evaluation of the effectiveness of improved methods on the total business. This work is being done under a cooperative agreement with General Foods Corporation. The initial phase of the study analyzed the warehousing, delivery, sales and office procedures. Recommendations, based on previous research and survey findings and on recommendations made by wholesalers attending the Institutional Food Distributors of America Convention in April 1962 and April 1963, were developed for each of these activities. The recommendations have been installed at the company. Some of the improvements include: an improved warehouse layout; improved order selection methods; and the development of a work schedule. The changes resulted in the elimination of overtime that previously cost the company \$10,000 annually and the provision of more space in the warehouse for storage of merchandise. Other improvements include a revised pricing schedule with price differentials based on total order size and the elimination of two delivery trucks by consolidating delivery routes. Cost of doing business as a percentage of sales was reduced from 15.1 to 13.9 percent of sales during the period. The model wholesaler was revealed with acclaim at the 1964 convention of the Institutional Food Distributors of America. Articles based on the experiment are being prepared by the Institutional Distribution magazine.

A manual entitled "Guides for Improving Institutional Wholesale Grocery Warehousing" was written and published. This manual is the result of testing and adapting previously developed principles for wholesale grocery warehouses supplying retail stores to institutional warehouse operations.

2. Cost of servicing different size orders. Under cooperative agreement with another leading grocery manufacturer, studies were conducted in three firms to determine the costs for efficiently servicing various size orders. The three firms were selected to represent a large, medium, and small size institutional wholesale business. The break-even point with the existing pricing methods in the three firms ranged from 7 to 37 cases at a delivery distance of 16 to 20 miles from the warehouse. A report entitled "A Method for Determining Cost of Servicing Wholesale Institutional Grocery Orders" has been prepared and is undergoing clearance for publication. In one firm, automatic tabulating equipment was installed after costs were obtained for the manual operation. Additional studies will be made of costs and methods with the automatic tabulating equipment and a guide prepared for installation of automatic tabulating equipment for institutional food distributors.

B. Improved Operational Practices for Food Service Institutions

1. School lunch kitchens. A research study was completed on improved layouts, equipment, space utilization and work methods in school lunch

kitchens, storage areas, and serving lines in three basic size schools having kitchen facilities on the premises. The study included collection of data on labor productivity, product flow, equipment utilization, and work schedules. The research was conducted under contract by Battelle Memorial Institute of Columbus, Ohio. It is anticipated that findings in this study will be particularly useful in the 68,200 schools having cafeteria kitchens and will be applicable to commercial operations. A final report on this study is in preparation.

PUBLICATIONS REPORTING RESULTS OF USDA AND COOPERATIVE RESEARCH

Improving Operations in Institutional Grocery Warehouses

- Bouma, J. C. 1964. Methods for Improving Warehouse Labor Productivity. Paper presented at Institutional Food Distributors of America Annual Convention. (Processed)
- Bouma, J. C. 1964. The Accomplishments in Two Years With Wholesaler "X." Institutional Food Distributors of America Annual Convention. (Processed)
- Hoecker, R. W. 1964. Looking Ahead in Institutional Selling. Paper presented at New England Wholesale Food Distributors Association. (Processed)
- Hoecker, R. W. 1964. Order Size Determines Profitability. Paper presented at NAWGA Workshop for Institutional Wholesalers. (Processed)
- Karitas, J. J. 1964. Institutional Wholesale Grocery Warehouse Operations. Paper presented at Retail and Warehouse Operations Research Clinic. (Processed)
- Karitas, J. J. 1964. Costs for Servicing Institutional Grocery Orders. Paper presented at Institutional Food Distributors of America Annual Convention. (Processed)
- Taliaferro, W. C. 1964. Guides for Improving Institutional Wholesale Grocery Warehousing. Marketing Bulletin No. 31, 18 pp.

Improved Operational Practices for Food Service Institutions

- Bouma, J. C. 1963. Institutional Food Distribution Research. Paper presented at Fourth Annual Food Distribution Research Conference. (Processed)
- Bouma, J. C. 1963. Possible Savings With Research on Food Service Operations. Paper presented at Food Service Executives Association. (Processed)
- Trieb, S. E. 1964. The Pennant Cafeteria Story. Paper presented at Retail and Wholesale Operations Research Clinic. (Processed)

PLANNING MARKET FACILITIES

Line Project Check List -- Reporting Year October 1, 1963 to September 30, 1964

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project	Incl. in
			Summary of Progress (Yes-No)	Area and Subheading
TF 1-9 <u>1/</u>	'Improving marketing facilities for the ' wholesale handling of food in Pittsburgh, ' Pennsylvania.	'Pittsburgh, Pa. 'Hyattsville, Md.	Yes	1-A-5
TF 1-13	'Preliminary and followup work in the ' development of improved marketing ' facilities in specific locations.	'Hyattsville, Md.	Yes	1-A-7 1-B-1-12 1-C-4
TF 1-14	'Planning and promoting the development of ' improved marketing facilities for fruits ' and vegetables in production areas.	'Hyattsville, Md.	Yes	1-C-3
TF 1-15	'Planning and promoting the development of ' improved marketing facilities for poultry ' products in production areas.	'Hyattsville, Md.	Yes	1-C-1
TF 1-16	'Planning and promoting the development of ' improved marketing facilities for live- ' stock and meat products.	'Hyattsville, Md.	Yes	1-C-2
TF 1-17	'Improving marketing facilities for the ' wholesale handling of food in Boston, ' Massachusetts.	'Boston, Mass. 'Hyattsville, Md.	Yes	1-A-2
TF 1-18	'Improving marketing facilities for the ' wholesale handling of food in Chicago, ' Illinois.	'Chicago, Ill. 'Hyattsville, Md.	Yes	1-A-1
TF 1-19 <u>2/</u>	'Improving marketing facilities for the ' wholesale handling of food in Milwaukee, ' Wisconsin.	'Milwaukee, Wisc. 'Hyattsville, Md.	Yes	1-A-4
TF 1-20	'Improving marketing facilities for the ' wholesale handling of food in Spring- ' field, Massachusetts.	'Springfield, Mass. 'Hyattsville, Md.	Yes	1-A-3
TF-0-0-1 (DC)	'Improving marketing facilities for the ' wholesale handling of food in San Juan, ' Puerto Rico.	'San Juan, Puerto ' Rico 'Hyattsville, Md.	Yes	1-A-6

1/ Discontinued May, 1964.

2/ Discontinued June, 1964.

AREA 2 - DAIRY PRODUCTS

Line Project Check List - Reporting Period Oct. 1, 1963 to Sept. 30, 1964

Work and Line Project Number	:	Work and Line Project Titles	:	Work Locations During Past Year	:	Line Proj. Incl. in Summary of Progress	:	Area and Sub- heading
TF 2	:	Improved Work Methods, Devices, Equipment, and	:		:		:	
	:	Related Facilities for the Off-Farm Conditioning,	:		:		:	
	:	Handling, Storage, Preparation for Market, and	:		:		:	
	:	Marketing of Agricultural Products.	:		:		:	
	:	Program Leadership	:	Hyattsville, Md.	:		:	
TF 2-31	:	Improved Layouts and Operating Criteria for	:		:		:	
(Rev.) 1/	:	Automated Dairy Plants	:	Hyattsville, Md.	:	Yes	:	2-A

1/ Extended May 1964.

AREA 3 - FIELD CROPS

Line Project Check List - Reporting Period Oct. 1, 1963, to Sept. 30, 1964

Work and: Line : Project : Number :	Work and Line Project Titles	Work Locations During Past Year	Line Proj. Incl. in Summary : Area of : and Sub- Progress: heading
TF 2	Improved Work Methods, Devices, Equipment, and Related Facilities for the Off-Farm Conditioning, Handling, Storage, Preparation for Market, and Marketing of Agricultural Products. Program Leadership	Hyattsville, Md.	
TF 2-2 (Rev.) ^{1/}	Laboratory Studies of Off-Farm Conditioning and Storage of Grains and Seeds.	Lafayette, Ind.	Yes 3-D-1
TF 2-2 (Rev.) ^{2/}	Testing and Evaluation of Crossflow, Counterflow, and Concurrent Flow Methods and Equipment for Continuous Grain Drying.	Lafayette, Ind.	Yes 3-D-1
TF 2-14 (Rev.)	Handling, Drying, and Other Conditioning of Medium- and Long-Grain Rough Rice at Commercial Dryers.	Beaumont, Tex.	Yes 3-F-1, 2, 3
TF 2-18 (Rev.) ^{2/}	Handling Grains, Seeds, and Feeds in Commercial Storages.	Manhattan, Kans.	Yes 3-C
TF 2-22 (Rev.) ^{3/}	Designs for Commercial Grain Storage Structures.	Hyattsville, Md.	Yes 3-E
TF 2-32 (Rev.)	Developing Improved Methods of Drying Field Shelled Corn for the Commercial Market.	Lafayette, Ind.	Yes 3-D-1
TF 2-33 (Rev.)	Handling Farmers Stock Peanuts at Commercial Storages.	Albany, Ga.	Yes 3-B-2
TF 2-34 (Rev.)	Conditioning and Storing Farmers Stock and Shelled Peanuts in Commercial Storages.	Albany, Ga.	Yes 3-B-3, 4
TF 2-44 ^{4/}	Duct Designs and Layouts for Grain Aeration Systems in Commercial Storages.	College Station, Tex.	Yes 3-D-2
TF 2-45 ^{5/}	Aerating Grain in Commercial Storages in the Southwest.	Beaumont, Tex.	Yes 3-D-2
TF 2-47	Aerating Wheat and Grain Sorghum in Commercial Storages in the Central Plains Area.	Manhattan, Kans.	Yes 3-D-2
TF 2-52	Aerating, Conditioning, and Handling CCC Stored Grain.	Watseka, Ill.	Yes 3-H
TF 2-57	Handling and Storage of Bales of Cotton.	Bakersfield, Cal.	Yes 3-G-1
TF 2-66	Cleaning and Shelling Farmers Stock Peanuts and Grading Shelled Peanuts.	Albany, Ga.	Yes 3-B-1
TF 2-70	Handling, Drying, Aerating, and Storing Cottonseed in Commercial Storages.	Stoneville, Miss.	Yes 3-A
TF 2-74	Conditioning Moist Grain in Upright Commercial Storages in the Hard Winter Wheat Area.	Manhattan, Kans.	Yes 3-D-1
TF 2-76 ^{6/}	Development of Satisfactory Equipment and Methods for Humidifying Cotton Storage Compartments to Maintain the Moisture Content of Stored Bales at Desirable Levels	Bakersfield, Cal.	Yes 3-G-2

^{1/} Second revision July 1964.

^{2/} Extended January 1964.

^{3/} Extended September 1964.

^{4/} Extended June 1964.

^{5/} Discontinued August 1964.

^{6/} Initiated September 1963.

AREA 4 - HORTICULTURAL CROPS

Line Project Check List--Reporting Year Oct. 1, 1963 to Sept. 30, 1964

Work and : Line : Project : Number :	Work and Line Project Titles	Work Locations : During : Past Year :	Line Proj. : Summary : of : Progress :	Incl. in : Area and : Sub- : heading :
TF 2	: Improved Work Methods, Devices, Equipment, and : Related Facilities for the Off-Farm Conditioning, : Handling, Storage, Preparation for Market, and : Marketing of Agricultural Products.			
	: Program Leadership	: Hyattsville, Md.		
TF 2-1	: Precooling Fruits and Vegetables	: Athens, Ga., and	Yes	: 4-G and
(Rev.)		: Wenatchee, Wash.		: 4-H
TF 2-3	: Handling, Storing, Cleaning, Grading, Sizing, and	: Presque Isle,	Yes	: 4-C-1
(Rev.) 1/	: Packing Maine Potatoes	: Maine		
TF 2-5	: Handling and Preparation for Market of Early Crop			: 4-C-2
(Rev.) 2/	: Potatoes	: Gainesville, Fla.	Yes	: and 4-I
TF 2-30	: TFRD Cooperation in WM-43, "Bulk Containers and Their:			
(Rev.)	: Effects on Costs and Efficiency and on the Structure :			
	: and Organization of Markets for Selected Agricultural:			
	: Commodities"	: Michigan	Yes	: 4-K-1
TF 2-36	: Measuring Cooling Rates of Apples	: Wenatchee, Wash.	Yes	: 4-E-1
(Rev.) 3/				
TF 2-37	: Methods, Equipment, and Facilities for the Storage			
(Rev.) 3/	: of Apples and Other Tree Fruits	: Wenatchee, Wash.	Yes	: 4-E-2
TF 2-38	: Controlled Atmosphere Storage of Apples in Pacific			
	: Northwest	: Wenatchee, Wash.	Yes	: 4-E-3
TF 2-51 4/	: Handling Concord Grapes in Processing Plants	: Michigan	Yes	: 4-J
TF 2-53	: Handling and Preparation for Market of Fall-Crop	: East Grand Forks,		
	: Potatoes	: Minn.	Yes	: 4-C-3
TF 2-54	: Cleaning and Sizing Fall-Crop Potatoes Before Storage:	: East Grand Forks,		
		: Minn.	Yes	: 4-C-3
TF 2-55	: Designs for Potato Storage and Packinghouses	: East Grand Forks,		
		: Minn.	Yes	: 4-F-1
TF 2-60	: Providing Optimum Conditions for the Storage of	: East Grand Forks,		
	: Potatoes for Processing	: Minn.	Yes	: 4-F-2
TF 2-61	: Degreening and Precooling Citrus	: Gainesville, Fla.	Yes	: 4-A, H
TF 2-62	: Presorting and Presizing Apples	: East Lansing,		
		: Mich.	Yes	: 4-B-2
TF 2-63	: Handling Citrus Fruits in Pallet Boxes	: Gainesville, Fla.	Yes	: 4-A
TF 2-64	: Methods, Equipment and Facilities for the Preparation:			
	: for Market of Citrus Fruits	: Gainesville, Fla.	Yes	: 4-A
TF 2-65	: Handling and Preparation for Market of Vegetables	: Gainesville, Fla.	Yes	: 4-D
TF 2-67	: Handling and Curing Sweetpotatoes	: Raleigh, N. C.	Yes	: 4-K-2
TF 2-68	: Impact of Color Sorting of Apples	: Wenatchee, Wash.	Yes	: 4-B-1
TF 2-69	: Presorting and Presizing Apples in Commercial			
	: Storages and Packinghouses	: Wenatchee, Wash.	Yes	: 4-B-1
TF 2-79 5/	: Handling and Preparation for Market of Peaches	: Athens, Ga.	Yes	: 4-B-3
TF 2-80 6/	: Preparing Maine Potatoes for Market	: Presque Isle,		
		: Maine	Yes	: 4-C-1
TF 2-81 6/	: Handling Maine Potatoes	: Presque Isle,		
		: Maine	Yes	: 4-C-1
TF 2-82 7/	: Preparing Spring Crop Potatoes for Market	: Gainesville, Fla.	Yes	: 4-C-2
				: and 4-I
TF 5	: Improved Methods, Operating Practices, Equipment,			
	: Materials, and Layout for Wholesaling and Retailing			
	: Farm and Food Products.			
TF 5-35 8/	: Loading Out Delivery Trucks of Fruit and Vegetable			
	: Wholesale Distributors	: Hyattsville, Md.	Yes	: 4-L-2

1/ Superseded by TF 2-80 and TF 2-81, August 1964.

2/ Superseded by TF 2-82, September 1964.

3/ Revised, approved September 1964.

4/ Discontinued August 1964.

5/ Initiated January 1964, approved March 1964.

6/ Supersedes TF 2-3 (Rev.) in part, approved August 1964.

7/ Supersedes TF 2-5 (Rev.), approved September 1964.

8/ Discontinued June 1964.

AREA 5 - LIVESTOCK, MEAT AND WOOL

Line Project Check List - Reporting Period Oct. 1, 1963 to Sept. 30, 1964

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Proj. Incl. in Summary of Progress	Area and Sub- heading
TF 2	Improved Work Methods, Devices, Equipment, and Related Facilities for the Off-Farm Conditioning, Handling, Storage, Preparation for Market, and Marketing of Agricultural Products. Program Leadership	Hyattsville, Md.		
TF 2-24	Improved Work Methods and Facilities for Frozen (Rev.2)1/ Portion Control Hotel Supply Houses	Stillwater, Okla.	Yes	5-F
TF 2-26	Designing a Physically Integrated Livestock Marketing: (Rev.) 2/ Slaughtering, and Wholesale Meat Market	Hyattsville, Md.	Yes	5-D
TF 2-35	Improved Layouts for Wool Warehouses (Rev.) 3/	Hyattsville, Md.	Yes	5-E
TF 2-42	Automation of Sales and Yarding Operations on Livestock Markets	Hyattsville, Md.	Yes	5-A, B, and C
TF 2-43	4/ More Efficient Work Methods, Equipment, and Facilities for the Killing Floors of Cattle Slaughter Plants	Stillwater, Okla.	Yes	5-G
TF 2-58	Improved Work Methods, Equipment, and Facilities for Hog Slaughter Plants	Stillwater, Okla.	Yes	5-H
TF 2-71	Work Methods, Equipment, and Facilities for Handling and Processing "Hot" Pork Products	Stillwater, Okla.	Yes	5-I

1/ Extended June 1964.

2/ Discontinued June 1964.

3/ Discontinued August 1964.

4/ Discontinued May 1964.

AREA 6 - POULTRY AND EGGS

Line Project Check List - Reporting Period Oct. 1, 1963 to Sept. 30, 1964

Work and : Line : Project : Number :	Work and Line Project Titles	Work Locations : During : Past Year :	Line Proj. Incl. in : Summary : of : Progress : Area and : Sub- : heading :
TF 2	: Improved Work Methods, Devices, Equipment, and : Related Facilities for the Off-Farm Conditioning, : Handling, Storage, Preparation for Market, and : Marketing of Agricultural Products. : Program Leadership	: : : : Hyattsville, Md.	: : : :
TF 2-10	: More Efficient Work Methods and Equipment for	: : Athens, Ga.	: : Yes : 6-E
(Rev.) 1/	: Eviscerating Chickens in Processing Plants	: : Hyattsville, Md.	: : Yes : 6-A
TF 2-17	: Improved Work Methods and Equipment for Grading	: : Davis, Calif.	: : Yes : 6-C
(Rev.) 2/	: and Packing Shell Eggs in Commercial Plants	: : Athens, Ga.	: : Yes : 6-F
TF 2-41	: Improved Methods, Techniques, and Equipment for : Cleaning Eggs	: : Athens, Ga.	: : Yes : 6-G
TF 2-49	: Improved Work Methods and Equipment for Cutting Up : and Packing Chickens in Processing Plants	: : Davis, Calif.	: : Yes : 6-J
TF 2-50	: Improved Layouts and Designs for Poultry Processing : Plants	: : Davis, Calif.	: : Yes : 6-D
TF 2-72	: Improved Methods, Equipment and Facilities for : Chilling, Weighing and Packing Turkeys in : Processing Plants	: : Davis, Calif.	: : Yes : 6-K
TF 2-73	: Improved Layouts and Engineering Designs for Egg : Grading and Packing Plants	: : Athens, Ga.	: : Yes : 6-H
TF 2-75	: Improved Methods, Equipment and Facilities for : Cutting-Up, Deboning and Preparing Turkey Specialty : Items	: : Athens, Ga.	: : Yes : 6-I
TF 2-77	: Methods, Equipment and Facilities for Improving : Plant Efficiency Through Balanced Inspection and : Evisceration Operations in Chicken Processing Plants	: : Athens, Ga.	: : Yes : 6-H
TF 2-78	: Improved Methods and Equipment for Handling Live : Chickens by Commercial Processing Plants	: : Athens, Ga.	: : Yes : 6-I

1/ Discontinued January 1964.

2/ Extended July 1964.

3/ Extended February 1964.

4/ Initiated March 1964.

CONSUMER PACKAGES AND SHIPPING CONTAINERS

Line Project Check List -- Reporting Year 1963 to 1964

Work and Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Project Incl. in	
			Summary of Progress (Yes-No)	Area and Sub- heading
TF 4	:Improved Transportation, Facilities, Equipment :and Methods and Improved Shipping Containers and :Packaging for Agricultural Commodities.			
TF 4-3 (Rev.)	:Prepackaging Fresh Fruits and Vegetables at the : Terminal Market Level	: Hyattsville, Md.	: No	:
TF 4-11	:Development and Evaluation of Improved Shipping : Containers for Fresh Pears	: Hyattsville, Md.	: No	:
TF 4-19	:Development and Evaluation of Consumer Packages : and Shipping Containers for Fluid Milk and Milk : Products	: Hyattsville, Md.	: Yes	: 7-E
TF 4-28 1/	:Prepackaging Fresh Apples at Point of Production	: Yakima, Wash.	: Yes	: 7-A-2
TF 4-29	:Prepackaging Fresh Pears at Point of Production	: Yakima, Wash.	: Yes	: 7-A-3
TF 4-30	:Prepackaging Fresh Peaches at Point of : Production in Southern, Middle West, and : Eastern States	: Hyattsville, Md.	: No	:
TF 4-31	:Prepackaging Stone Fruits and Grapes at Point : of Production	: Yakima, Wash. : Fresno, Calif.	: Yes	: 7-A-4
TF 4-32	:Prepackaging Citrus Fruits and Point of : Production	: Orlando, Fla.	: Yes	: 7-B
TF 4-33	:Prepackaging Potatoes at Point of Production	: Hyattsville, Md.	: No	:
TF 4-34	:Prepackaging Celery at Point of Production	: Fresno, Calif.	: Yes	: 7-C-3
TF 4-35	:Prepackaging Fresh Sweet Corn at Point of : Production	: Hyattsville, Md.	: No	:
TF 4-36	:Prepackaging Green Beans at Point of Production	: Orlando, Fla.	: Yes	: 7-C-4
TF 4-37	:Prepackaging Fresh Asparagus at Point of : Production	: Fresno, Calif.	: Yes	: 7-C-2
TF 4-44	:Development and Evaluation of Improved Shipping : Containers for Peaches	: Orlando, Fla. : Hyattsville, Md.	: Yes	: 7-A-1
TF 4-45	:Development and Evaluation of Improved Shipping : Containers for Apples	: Yakima, Wash. : Hyattsville, Md.	: Yes	: 7-A-2
TF 4-46	:Development and Evaluation of Improved Shipping : Containers for Grapes	: Fresno, Calif.	: Yes	: 7-A-4
TF 4-47	:Development and Evaluation of Improved Shipping : Containers for Sweet Corn	: Hyattsville, Md.	: No	:
TF 4-48	:Prepackaging Lettuce at Point of Production	: Fresno, Calif.	: Yes	: 7-C-1
TF 4-49	:Prepackaging Onions at Point of Production	: Hyattsville, Md.	: No	:
TF 4-50	:Prepackaging Sweetpotatoes at Point of : Production	: Hyattsville, Md.	: No	:

1/ Terminated

(Continued)

CONSUMER PACKAGES AND SHIPPING CONTAINERS

Line Project Check List -- Reporting Year 1963 to 1964 (Continued)

Work and Line Project Number	:	:	:	:Line Project Incl. in	
				Summary of	Area and
:	:	:	:	Progress	Sub-
				(Yes-No)	heading
Work and Line Project Titles	:	:	:	During Past Year	:
TF 4-51	:	:	:	:	:
:Development of New or Improved Packages and	:	:	:	:	:
: Packing Materials for Prepackaging Fresh and	:	:	:	:	:
: Frozen Cutup Poultry	:	:	:	:	:
:	:	:	:	:	:
TF 4-54 <u>2/</u>	:	:	:	:	:
:Development and Evaluation of Improved Shipping	:	:	:	:	:
: Containers for Fresh Western Pears, Peaches,	:	:	:	:	:
: Nectarines and Apricots	:	:	:	:	:
:	:	:	:	:	:
Exp. 1	:	:	:	:	:
:Cotton Baling Materials	:	:	:	:	:
:	:	:	:	:	:

2/ Initiated

TRANSPORT EQUIPMENT AND TECHNIQUES

Line Project Check List -- Reporting Year 1963 to 1964

Work and Line Project Number	Work and Line Project Titles	Work Location During Past Year	Line Project Incl. in Summary of Area and Progress Sub- (Yes-No) heading	
TF 4	:Improved Transportation, Facilities, Equipment :and Methods and Improved Shipping Containers and :Packaging for Agricultural Commodities			
TF 4-6 (Rev.)	:Pallet Containers for Transportation	: Hyattsville, Md.	: Yes	: 8-A-1
TF 4-21	:Improved Loading Methods for Apples	: Hyattsville, Md.	: No	
TF 4-23	:Thermal Rating of Refrigerated Trucks	: Hyattsville, Md.	: Yes	: 8-A-1
TF 4-24	:Air Circulation in Refrigerated Trucks	: Hyattsville, Md.	: Yes	: 8-A-2
TF 4-25 <u>1/</u>	:Improved Loading Methods for Potatoes	: Hyattsville, Md.	: Yes	: 8-B-2
TF 4-26	:Improved Loading of Watermelons	: Hyattsville, Md.	: Yes	: 8-B-3
TF 4-38 <u>1/</u>	:Liquid Nitrogen Refrigeration for Frozen Food : Trailers	: Hyattsville, Md.	: Yes	: 8-A-3
TF 4-39	:Performance of Frozen Food Trailers of New Design; : and Construction	: Hyattsville, Md.	: No	
TF 4-40	:Improved Performance of Refrigerated Cars and : Trailers Hauling Fresh Meats	: Hyattsville, Md.	: No	
TF 4-41	:Improved Baskets and Loading of Fresh Peas	: Hyattsville, Md.	: Yes	: 8-B-4
TF 4-42	:Improved Loading of Onions	: Hyattsville, Md.	: Yes	: 8-B-5
TF 4-43 <u>1/</u>	:Improved Loading of Citrus	: Orlando, Fla.	: Yes	: 8-B-6
TF 4-52	:Unitized and Palletized Transport	: Hyattsville, Md.	: Yes	: 8-B-7
TF 4-53 <u>2/</u>	:Multi-use Transport Vehicles	: Hyattsville, Md.	: Yes	: 8-A-4
Exp. 1 <u>2/</u>	:Improved Ventilated Piggyback Trailers	: Orlando, Fla.	: Yes	: 8-A-5
Exp. 2	:Overseas Transport	: Hyattsville, Md.	: Yes	: 8-B-8

1/ Terminated

2/ Initiated

RETAIL FOOD STORE OPERATIONS

Line Project Check List -- Reporting Year October 1, 1963 to September 30, 1964

Work & Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Proj. Incl. in	
			Summary of Progress	Area and Subheading
TF 5 (Rev.)	Improved methods, operating practices, equipment, materials, and layout for wholesaling and retailing of farm and food products.			
TF 5-20	Alternative techniques for handling produce in retail food stores.	Hyattsville, Md.	Yes	9-B-2
TF 5-21	Improved preparation and packaging of produce at the central warehouse.	Hyattsville, Md.	Yes	9-B-1
TF 5-22	Systems and equipment for packaging and price marking meat and poultry in retail food stores.	Hyattsville, Md.	Yes	9-A-2
TF 5-23	Tray display for meat, poultry, and delicatessen products in retail food stores.	Hyattsville, Md.	Yes	9-A-3
TF 5-24	Central preparation and packaging of meat and poultry products for retail sale.	Hyattsville, Md.	Yes	9-A-1
TF 5-26	Increased efficiency of small stores, superettes, and supermarkets through the adaptation of research results.	Hyattsville, Md.	Yes	9-D-1
TF 5-28	Dairy department operation in retail stores and central warehouses.	Hyattsville, Md.	Yes	9-C-1
TF 5-31	Improved retail bakery department methods and practices.	Hyattsville, Md.	Yes	9-C-2
TF 5-36	Optimum work methods, equipment, layout, and store organization for the total retail food store.	Hyattsville, Md.	Yes	9-D-2
TF 5-38	The effect of improved techniques of sanitation and temperature control in retail processing of meat.	Hyattsville, Md.	Yes	9-A-4

WHOLESALE FOOD OPERATIONS
Line Project Check List -- Reporting Year October 1, 1963 to September 30, 1964

Work & Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Proj. Incl. in	
			Summary of Progress	Area and Subheading
TF 5 (Rev.)	Improved methods, operating practices, equipment, materials, and layout for wholesaling and retailing of farm and food products.			
TF 5-19	Improved methods to control damage and breakage and to handle salvable merchandise and materials in food stores and grocery warehouses.*	Hyattsville, Md.	Yes	10-A-1
TF 5-30	Costs, margins, and operating ratios as determined through uniform accounting in wholesale food distribution businesses--cooperative with Marketing Economics Division.	Hyattsville, Md.	Yes	10-C-1
TF 5-32	Improved inventory control and space allocation in wholesale grocery warehouses.	Hyattsville, Md.	Yes	10-C-2
TF 5-34	Improved methods, operating practices, equipment, materials, and layout for warehousing and delivery of fresh meats in chainstore organizations.	Hyattsville, Md.	Yes	10-B-2
TF 5-35	A comparison of selected methods for loading out delivery trucks of wholesale distributors of fresh fruits and vegetables.	Hyattsville, Md.	Yes	10-B-1

* Discontinued during reporting year.

INSTITUTIONAL FOOD SERVICE OPERATIONS

Line Project Check List -- Reporting Year October 1, 1963 to September 30, 1964

Work & Line Project Number	Work and Line Project Titles	Work Locations During Past Year	Line Proj. Incl. in	
			Summary of Progress	Area and Subheading
TF 5 (Rev.)	Improved methods, operating practices, equipment, materials, and layout for wholesaling and retailing of farm and food products.			
TF 5-10	Improving operations in institutional grocery warehouses.	Hyattsville, Md.	Yes	11-A
TF 5-37	Improved methods, operational practices, equipment, materials, and layout for school lunch cafeterias and serving lines.	Hyattsville, Md.	Yes	11-B



